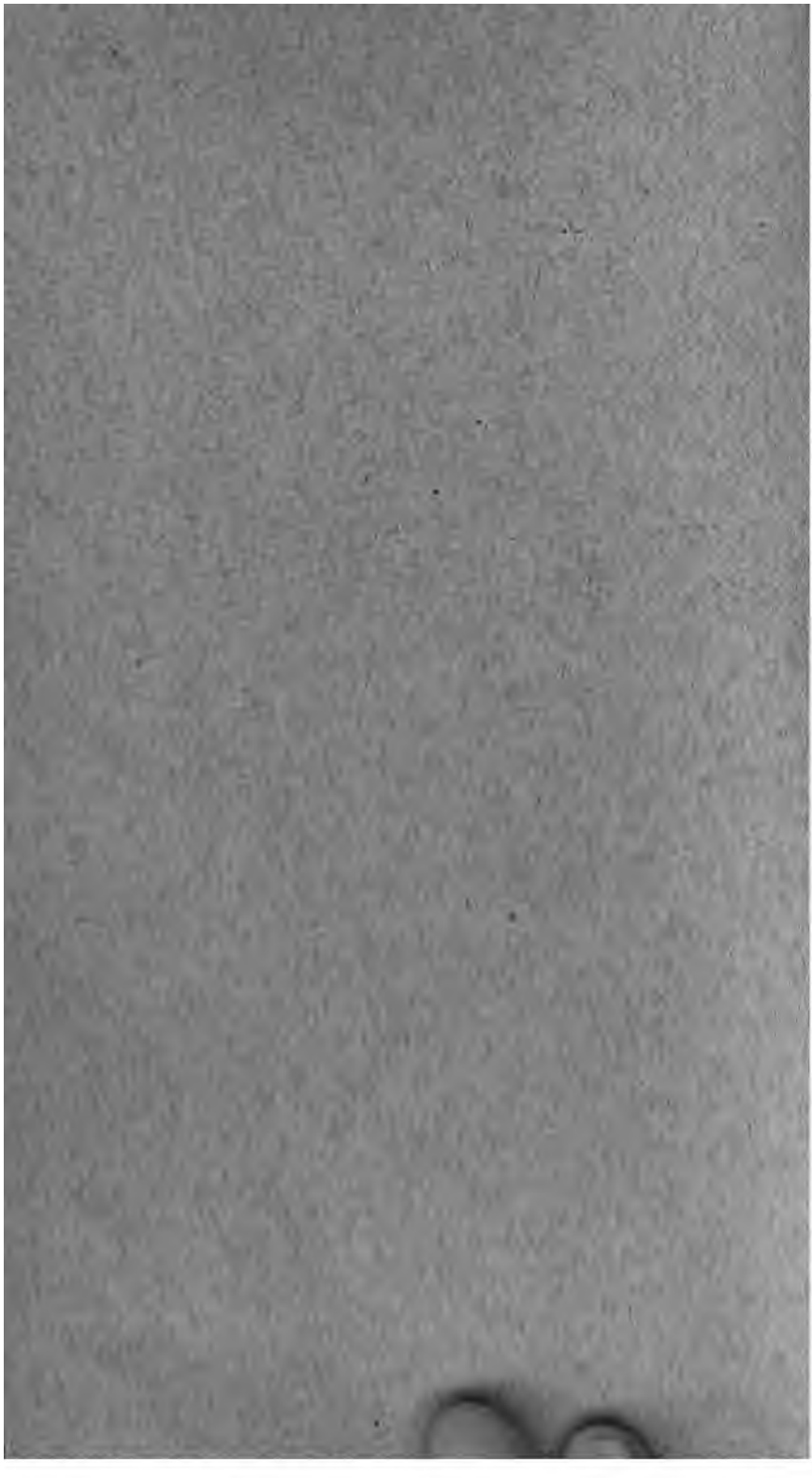

THE

ATLANTIC & PACIFIC

SHIP-RAILWAY

ACROSS THE

ISTHMUS OF TEHUANTEPEC,

IN MEXICO,

Considered Commercially, Politically & Constructively.

BY

ELMER L. CORTHELL,

Chief Engineer.

JANUARY, 1886.

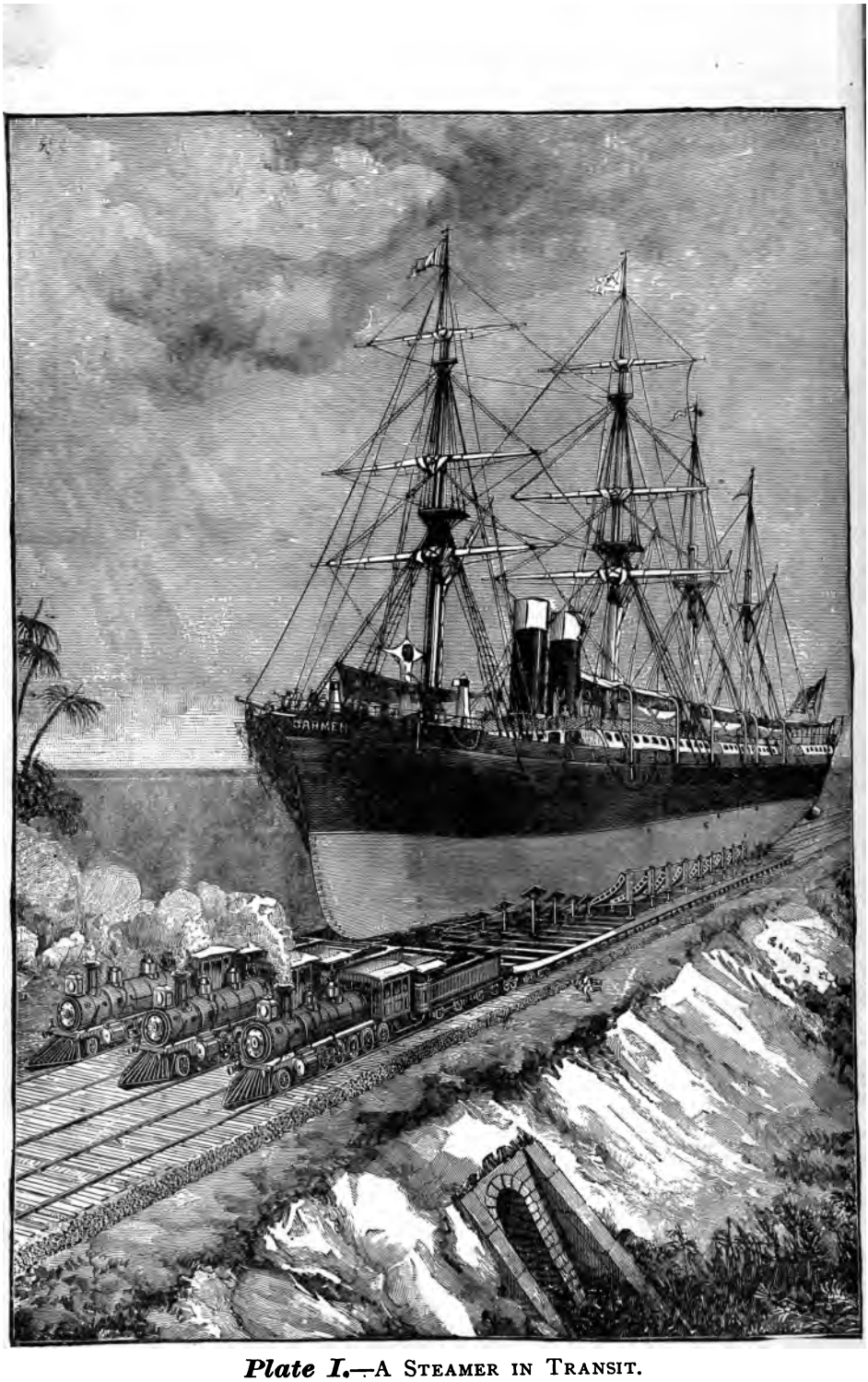

Plate I.—A Steamer in Transit.

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CONTENTS.

CHAPTER I.

PAGE.

The constant and undiminished Importance of the East during the last three thousand years, as the Source of the Wealth and Trade of the World 3

CHAPTER II.

Opinion of American Statesmen during the last sixty years upon the vast importance to this country of an Interoceanic Communication, and upon the Necessity, Right and Policy of the United States to encourage and protect any Isthmian Crossing between the two Oceans 8

CHAPTER III.

Commercial and Industrial Facts showing the paramount importance of an Isthmian Crossing and its Imperative Necessity 17

CHAPTER IV.

Superior Advantages of the Tehuantepec Isthmus—Commercial, Climatic, Constructive and Strategic 23

CHAPTER V.

The Ship-Railway, its Plans, Practicability and Economy 33

CHAPTER VI.

Distances saved.—Tonnage expected.—Government Status of the Enterprise.—Benefits to the United States and Mexico during the Construction.—General Results 63

CHAPTER VII.

Reports of Congressional Committees approving the Ship-Railway route and method, and urging Government Assistance 70

PLATES.

I. A Steamer in Transit..... ..... Frontispiece.

II. Map showing Tehuantepec to be the great Central Barrier to the World's Commerce..... 22

III. Perspective View of the Dock and Car..... 36

IV. Details of the Lifting Dock..... 39

V. Details of the Car..... 41

VI. Perspective View of the Floating Turntable..... 45

VII. Details of the Floating Turntable..... 47

PREFACE.

THE purpose of the Author in the following pages is to present, in a concise yet comprehensive form, the commercial and political reasons for an interoceanic communication between the Atlantic and Pacific at the Isthmus of Tehuantepec in Mexico ; also to bring together the more important facts that prove the practicability and the economy of a Ship-Railway. The previous discussions, while complete in detail, have been partial and fragmentary. The writer has had exceptional advantages in investigating this subject ; he made examinations on the Isthmus and the surveys of its harbors in 1880, and has since that time conducted, through very efficient and experienced engineers, complete topographical surveys of the Isthmus, on which the plans, profiles and estimates are based.

THE

ATLANTIC AND PACIFIC

SHIP-RAILWAY.

CHAPTER I.*

HISTORICAL.

"THE problem of interoceanic transit across the American "continent has been said to 'possess not only practical value but "historic grandeur'. Its partial solution is being attained by the "construction of those railways which are bringing nearer to us "so much of the eastern world; but it can be fully solved only "when such a work has been made as will prove a maritime highway "for America and Europe to the western shores of the continent, "to the new world of Australia and its surroundings, to Eastern "Asia, and to Japan. To meet the requirements which commerce, "supported by all the advanced appliances of this day, imperatively "demands, the transit must offer the allurements of a full, "uninterupted, safe, and speedy transportation. * * *

"History invests the problem with an interest surpassing that of "its usual records. In this effort to secure a western route to Asia "and the Spice Islands it is linked back to the age of the great "discoverer; and since the object held by Columbus for his "sovereigns was the same with that of the ages preceding, the "problem thus reaches back to the story of the coveted wealth "of Asia and of the old highways to it.

"India and China! what tales of marvelous endeavor to secure "their riches remain on the pages of authentic history! Both "countries, from time immemorial, famed for the richness and "variety of products secured by the caravan which sought them by "weary routes from the west. These were the storehouses of "product and luxury, drawn upon more and more as the facilities "of commerce and land travel enlarged themselves, yet ever, as "to-day, without sensible decrease. The labors of the Old World "were to reach them by an eastern route; the labor of the New

* The quotations in the first part of this chapter are from the pen of Professor J. E. Nourse, U. S. N.

"World is to reach them by the west. Through the whole period "of history, ancient and modern, it is the same drawing upon the "resources of the east. It was their traditional inexhaustibility that "stimulated the progress of discovery in the Middle Ages, opened "up the New World itself, and has left for our day the problem of "the new transit. It has been reserved for our age, however, to "crown the motives of the past with the higher purpose of extending "over the east the highest types of civilization and Christian "enlightenment, hopefully to be conferred upon it by thus advancing "the closer intercourse and fellowship of men.

"The student of commercial history is instructed that during the "last 3000 years the steady tendency of commercial enterprise has "been toward the west, and that 'civilization has followed the sun "in its course.' The steps of that progressive tendency are links in "the earlier history of our problem. * * *

"To look through the chapters of ancient history, is to recall "without difficulty the fact that each of the great empires of "antiquity owed its supremacy to the conquests of commerce as "well as war. * * * As a single instance of "the richness of that commerce, it may be remembered that from "one voyage the fleets of Solomon brought back gold equal in value "to nearly fourteen and a-half millions of dollars. * * *

"In the days of Augustus the amount of the precious metals sent "to India to pay for products for which there was no corresponding "exchange by the produce of the west, was estimated at 100,000,000 "sesterces, or $40,000,000. The consignments which reached "Alexandria from the east were directed to every port in the "Mediterranean. * * *

"Before the awakening of Europe from the sleep of 'the dark "ages', the Italians by their intercourse with Constantinople and the "other cities of the Greeks having obtained a knowledge of the east "and cultivated a taste for its precious commodities, were not slow "to embrace and develop direct intercourse with India, and, in the "course of the twelfth century, Venice established a regular trade "through the ports of Egypt, which she maintained for four "centuries.

"The marvelous ascendency which the Mistress of the Isles thus "acquired, aroused and stimulated the next great commercial "enterprise of the world's history. The Portuguese, who for "generations had sought to discover the realms of gold, in 1498 "established a maritime ascendency which extended over the coasts "of Africa and Asia, from Mozambique to Japan; whilst their

"famous cities of Goa, Malacca, and Macao became emporiums of "trade with India and China, which had previously enriched "Venice and Genoa.

"From that date, eastern commerce, falling successively into the "hands of the Dutch and the English, has at length assumed "proportions which bear no comparison with those of the earlier "ages. A new title has been jeweled into the crown of England "while the great highway, the realized dream of ages, is freighted "daily from the same storehouses of the east, enriching not only "Europe but the shores on our side of the globe.

"The first bold crossing of 'the sea of darkness' links the "commercial activities of the Old World with the New in the person "of the great discoverer. The expectation of being able to sail "westward to the Spice Islands without interruption was the "principal motive of Columbus in undertaking the voyage which "first marked the limits of the Atlantic. * * *

"The chief object of his last voyage indicates, in a marked degree, "his idea of Asia, since it was undertaken with the single purpose of "seeking along the coast of the Caribbean sea the Strait which he "imagined formed a communication between his discoveries and "India. * * *

"'He had been in pursuit of a chimera of a splendid imagination "'and a penetrating judgment. If he was disappointed in his "'expectations of finding a strait through the Isthmus of Darien, it "'was because nature herself was disappointed. For she appears "'to have attempted to make one, but to have attempted in vain.' *

'This search for the secret of the strait marks the first era in the "history of direct efforts for interoceanic communication across "America. From this date it is a record of continuous and "unavailing effort to find the strait, and on a failure of this, a "record of numberless canal and railroad projects for an artificial "transit. ' * * *

"The discovery of the Pacific by Balboa, and its entrance by "Magellan, kept alive for more than a quarter of a century the "erroneous ideas of the strait. Since it was now certain that the "new lands were not the Indies, the next thing was to carry forward "the search for the narrow passage which must lead to them. "The very configuration of the Isthmus strengthened the belief in "the existence of such a passage by the number of its openings, "which seem to invite entrance in the expectancy that some of them

---

* Washington Irving.

"must extend across the narrow breadth of land. For this great "purpose, and in full expectancy of success, the whole coast of the "New World on each side, from Newfoundland, as visited by the "Cabots, on the northeast, and thence south around the whole "sweep of the Mexican Gulf, and the Caribbean Sea, around South "America, and up the Pacific to Behring Straits, was searched and "researched with diligence. Men, says Humboldt, could not "accustom themselves tc the idea that the continent extended "uninterruptedly from such high southern to such high northern "latitudes. * * *

"The continuous search for the strait, made under the orders and "direct superintendence of Cortez, at length resulted in putting an "end to all hope in that direction. Charles V. had urged the search. "In a letter from Valladolid, in 1533, he enjoined the most careful "inquiry 'for the passage which would connect the eastern and "western shores of the New World, and shorten by two-thirds the "route from Cadiz to Cathay;' and Cortez, in his reply, expressed "the highest hopes of success. 'It would render the King of Spain "master of so many kingdoms that he might call himself Lord of the "World'. The instructions of the court and the subsequent letters "of the conquerer, as well as the correspondence of men of science, "were always full of the idea. 'For the proximity of the two oceans "in certain parts of the Isthmus having been this time ascertained, "it could not yet be believed that nature had worked on a plan so "apparently repugnant to the interests of humanity as to interpose, "through the whole length of the new continent, such a barrier to "communication between the great seas'. The conqueror of "Mexico never abandoned this leading object in his reverses, nor "forgot it in his triumphs. * * *

"He ascertained that, instead of the outlet before supposed to "exist towards the north, the unknown ocean was locked up in the "arms of the mighty continent. The hope of finding a short passage "across the Isthmus thus perished. * * *

"The Spanish historian, Gomara, seems first to have proposed an "artificial opening through the Isthmus. In 1551, representing, "doubtless, the general feeling in Spain and in the New World, he "urged on Philip II. the union of the oceans by three of the same "routes which at this day are still before the world, Tehuantepec, "Nicaragua and Panama; and had Spain remained what she had "been under Charles V., what had been in vain sought from nature "might have been in some degree supplied by man. Her men of "science had urged the work, and all Spain had awakened to it.

" 'It is true,' said Gomara to the Emperor, 'that mountains " obstruct these passes, but if there are mountains, there are also " hands. Let but the resolve be made, there will be no want of " means; the Indies, to which the passage will be made, will supply " them. To a King of Spain, with the wealth of the Indies at his " command, when the object to be attained is the spice trade, what " is possible is easy.' * * *

" Since the glorious age of Balboa, among the people, indeed, the " project of a canal was in every one's thoughts. In the very wayside " talks, in the inns of Spain, when a traveler from the New World " chanced to pass, after making him tell of the wonders of Lima " and Mexico, of the death of the Inca Atahualpa, and the bloody " defeat of the Aztecs, and after asking his opinion of El Dorado, " the question was always about the two oceans, and what great " thing would happen if they could succeed in joining them."

For nearly three hundred and fifty years, governments, companies and individuals have made surveys and plans, and brought forward projects of canals and railroads to overcome this important obstacle to the commerce of the world. The celebrated Portuguese navigator Altono Galva, in 1550, wrote a treatise on the subject and suggested several different lines for crossing the Isthmus. One of the earliest exploits of Nelson was an attack on the port of San Juan in Nicaragua in 1779, with the purpose of controlling communication between the two oceans. King Charles III. of Spain sent an exploring expedition to the Isthmus under Manuel Galistro in 1780. Humboldt studied the subject on the Isthmus itself, and strongly urged a transit-way. All the Central American Republics, immediately after securing their independence, brought forward projects for inter-oceanic communication. In 1826, the Mexican government ordered the survey of the Tehuantepec Isthmus to be made by Gen. Orbegozo. Several of the Central American republics gave concessions and contracts to individuals and companies of different nations, looking to the construction of canals or railroads. The United States government has sent several expeditions, under charge of naval and army officers and civil engineers, to examine and survey various routes across the Isthmus. Mr. Frederick M. Kelly, a wealthy New York merchant, induced at first by the statements of Humboldt in regard to the feasibility of a canal through Darien, spent a large fortune in explorations of the Isthmus. He not only sent several parties there under prominent engineers, but also appeared before leading men of Europe and their governments, and the gov-

ernment of the United States, asking their assistance in solving this great problem. Some of the most skillful naval officers and army engineers have, under the United States government, made surveys of many parts of the Isthmus.

CHAPTER II.

OPINIONS OF AMERICAN STATESMEN DURING THE LAST SIXTY YEARS UPON THE VAST IMPORTANCE TO THIS COUNTRY OF AN INTEROCEANIC COMMUNICATION, AND UPON THE NECESSITY, RIGHT AND POLICY OF THIS GOVERNMENT TO ENCOURAGE AND PROTECT ANY ISTHMIAN CROSSING BETWEEN THE TWO OCEANS.

In 1826, Henry Clay, Secretary of State, in a letter of instructions to the Commissioners of the United States to the Congress of Panama, said:

"A cut or canal for purposes of navigation somewhere through "the isthmus that connects the two Americas, to unite the Pacific "and Atlantic Oceans will form a proper subject of consideration "by the Congress. That vast subject, if it should ever be accom- "plished, will be interesting in a greater or less degree to all parts of "the world. But to this continent will probably accrue the largest "amount of benefit, from its execution; to Colombia, Mexico, the "Central Republic, Peru, and the United States, more than to any of "the other American nations. What is to redound to all America "should be effected by common means and united resources, and "should not be left to the unassisted efforts of any one power. In "the present limited state of our information as to the practicability "and the probable expense of the object, it would not be wise to "do more than to make some preliminary arrangements. The best "route will be most likely found in the territory of Mexico or that "of the Central Republic. * * *

"You will inquire particularly as to what has been done, or may "have been designed by Spain, or by either of the new States, and "obtain all other information that may be within your reach to solve "this interesting problem. You will state to the ministers of the "other American powers that the Government of the United States "takes a lively interest in the execution of the work and will see with

" peculiar satisfaction that it lies within the compass of reasonable " human efforts."

In 1835, President Jackson commissioned Mr. Charles Biddle to go to the Isthmus and study the subject of interoceanic communications. In 1839, the chairman of the Committee on Roads and Canals of the House of Representatives, Mr. C. F. Mercer, presented a report on the subject, urging negotiations for an interoceanic crossing. In the beginning of his report he said :

" It is obvious that if the contemplated communication from sea " to sea be practicable, the nation which has the right to appropriate " its exclusive use to itself might lawfully control the richest com- " merce of the world, or prescribe to all other nations the terms upon " which they be admitted to share its enjoyment. The policy is not " less apparent which should prompt the United States to co-operate " in this enterprise liberally and efficiently. * * * If other con- " siderations did not prompt this decision, it should suffice for its " confirmation to contrast the continuous voyage of the same vessel " across the two oceans, divided by the Isthmus, with the trans-ship- " ment of a heavy cargo between vessels of equal burden, and the " intervening expense of land transportation, double port duties, " and commissions, added to the damage of shifting and exposing " very valuable commodities to waste and depredation. The United " States, whose territory extends from the Atlantic to the Pacific, " cannot but regard with solicitude any eterprise which, if prac- " ticable, will so greatly approximate their eastern and western " frontiers."

In 1847, during the negotiations between the two Republics, which finally resulted in the treaty of Guadalupe Hidalgo of 1848, James Buchanan, then Secretary of State, sent the following instructions to Nicholas P. Trist, the Commissioner of the United States at the City of Mexico : " Instead of fifteen millions of dol- " lars stipulated to be paid by the fifth article for the extension of " our boundary over New Mexico and Upper and Lower Cali- " fornia, you may increase the amount to any sum not exceeding " thirty millions of dollars, payable by instalments of three millions " per annum, provided the right of passage and transit across the " Isthmus of Tehuantepec, secured to the United States by the " eighth article of the project, shall form a part of the treaty."

In 1850, Daniel Webster, while Secretary of State, said in a letter to the United States Minister at Mexico : " The American public at " large has a great and obvious interest in the Tehuantepec pas-

"sage."* In another letter, in 1851, he said: "No one can fail to "see how exceedingly important this communication would be to "the Government of Mexico. It proposes to give her a practical "highway from sea to sea. It opens to her a communication on the "one side and the other with the eastern and western worlds. It "gives her access to the markets of all nations and makes her, in "short, a central point of the commerce of modern times."

In 1851, President Fillmore said, in his message to Congress:

"In negotiating upon this important subject, this Government has "had in view one and only one object. That object has been and "is the construction or attainment of a passage from ocean to ocean, "the shortest and the best for travelers and merchandise, and equally "open to all the world. It has sought to obtain no territorial acqui- "sition nor any advantages peculiar to itself, and it would see with "the greatest regret that Mexico should oppose any obstacle to the "accomplishment of an enterprise which promises so much conven- "ience to the whole commercial world and such eminent advantages "to Mexico herself. Impressed with these sentiments and these con- "victions the Government will continue to exert all proper efforts "to bring about the necessary arrangement with the Republic of "Mexico for the speedy completion of the work."

That illustrious statesman, Lewis Cass, in an official letter, while Secretary of State, in 1857, said:

"The proximity of the Isthmus" (Tehuantepec) "to our shores, the "salubrity of the climate, the adaptness of the ground for the con- "struction of the railroad, and the great diminution of distance in "comparison with traveled routes between our Atlantic and Pacific "possessions, all conspire to point it out as far preferable to any "other route."

In 1858, he stated the principles on which any interoceanic transit-way must rest as far as this country is concerned, "what the "United States want in Central America, next to the happiness of "its people, is the security and neutrality of the interoceanic routes "which lead through it."

The vast importance of this subject was fully appreciated by that great statesman, William H. Seward, who used the following language in regard to it:

"During the past three hundred years, statesmanship and humani.

* Sen. Exec. Doc. 97, Thirty-second Congress, First Session.

"tarianism have combined with ever increasing diligence and effort "to find the means of effecting an enterprise which is, perhaps, the "only one that ever has commanded universal assent and com- "mended itself to the desire of all mankind. Every advance of "modern civilization in Europe, the establishment of every new "nation in America, every opening of any secluded Asiatic state "and nation that has occurred, has increased the zeal and the energy "of the friends of progress in favor of a canal across the American "Isthmus."

President Hayes, in 1880, in a special message to Congress, stated:

"An interoceanic canal across the American Isthmus will essen- "tially change the geographical relations between the Atlantic and "Pacific coasts of the United States, and between the United States "and the rest of the world. It will be the great ocean thoroughfare "between our Atlantic and Pacific shores, and virtually a part of the "coast line of the United States. Our merely commercial interest "in it is greater than that of all other countries, while its relations to "our power and prosperity as a nation, to our means of defense, our "unity, peace and safety, are matters of paramount concern to the "people of the United States."

Ex-Secretary of the Treasury, Hon. Wm. Windom, while a member of the U. S. Senate, said in an address to that body, February 28th, 1881:

"Bordering upon the Gulf on the north lie the great States of "Texas, Louisiana, Mississippi, Alabama and Florida. North of "these lies the mighty empire drained by the Mississippi River, "while to the east are the Atlantic States, stretching from Florida to "Maine. On the Pacific are the States of California, Oregon and "Washington Territory, and from the Atlantic to the Pacific "stretches a domain whose magnificence is the pride of every Amer- "ican. Obstructing, embarrassing and burdening the commerce "between these great sections of the Union, lies this narrow strip of "land. * * * * To avoid it, 1,200,000 tons of wheat raised in "California and Oregon last year were compelled to seek a Euro- "pean market by a costly and tedious voyage of fourteen thousand "miles around Cape Horn. Even the exchange of productions be- "tween our own Atlantic and Pacific States must be made by the "same circuitous, expensive and dangerous route, or else sustain "the heavy burdens imposed for railway transportation across the

"continent. The commerce of all the leading nations is in like man-
"ner obstructed and burdened. The time has come when this bar-
"rier is to be removed. The wonder is that it has been permitted
"to remain so long."

The importance to this country of an interoceanic communication was very forcibly presented in a letter to the Minister of the United States at London, May 8th, 1882, by the Secretary of State, Hon. James G. Blaine:

"The possessions of the United States upon the Pacific coast are
"imperial in extent and of extraordinary growth. Even at their
"present stage of development they would supply the larger part of
"the traffic which would seek the advantage of the canal. The
"States of California and Oregon, and the Territory of Washington,
"larger in area than England and France, produce for export more
"than a ton of wheat for each inhabitant, and the entire freights de-
"manding water transportation eastward, already enormous, are
"augmenting each year with an accelerating ratio. While the popu-
"lation and products of the Pacific slope are thus increasing upon a
"vast scale, the railway system connecting the Gulf of Mexico with
"the interior and with the Great Lakes is being rapidly extended,
"thus affording additional facilities for enlarging the commerce that
"must seek the coast line to the Pacific, of which the projected
"canal at Panama will form a part, and be as truly a channel of com-
"munication between the Eastern and far Western States as our own
"transcontinental railways. It is the perception of this domestic
"function of the long-sought water-way between the two seas that
"border the Republic, which has caused the project to be regarded
"as of vital importance by this government. The history of the
"enterprise is marked from the outset by the numerous expeditions
"which have from time to time been sent out by the United States
"at large expense to explore the various routes, and thus facilitate
"the work when the time should be ripe and the vast capital be
"forthcoming for the undertaking."

In a message of President Arthur, occurs the following statement on this subject:

"The establishment of water communication between the Atlan-
"tic and Pacific Coasts of the Union is a necessity, the accomplish-
"ment of which, however, within the territory of the United States
"is a physical impossibility. While the enterprise of our citizens
"has responded to the duty of creating means of speedy transit by
"rail between the two oceans, these great achievements are inade-

"quate to supply a most important requisite of national union and "prosperity. For all maritime purposes, the States upon the Pacific "are more distant from those upon the Atlantic than if separated by "either ocean alone. Europe and Africa are nearer New York, and "Asia is nearer to California than are these two great States to each "other by sea. Weeks of steam voyage, or months under sail, are "consumed in the passage round the Horn with the disadvantage of "traversing tempestuous waters or risking the navigation of the Straits "of Magellan. A nation like ours cannot rest satisfied with such a "separation of its mutually dependent members. We possess an "ocean border of considerably over ten thousand miles on the At-"lantic and Gulf of Mexico, and, including Alaska, of some ten "thousand miles on the Pacific. Within a generation the western "coast has developed into an empire, with a large and rapidly grow-"ing population, with vast but partially developed resources. At "the present rate of increase, the end of the century will see us a "commonwealth of, perhaps, nearly a hundred million inhabitants, "of which the west should have a considerably larger and richer "proportion than now.

* * * *

"From a purely commercial point of view the completion of such "a waterway opens a most favorable prospect for the future of our "country. The nations of the Pacific Coast of South America will "by its means be brought into closer connection with our Gulf "States. The relation of these American countries to the United "States is that of a natural market from which the want of direct "communication has hitherto practically excluded us. By piercing "the Isthmus the heretofore insuperable obstacles of time, sea, and "distance disappear, and our vessels and productions will enter upon "the world's competitive field with a decided advantage of which "they will avail themselves. When to this is joined the large coast-"ing trade between the Atlantic and Pacific States, which must "necessarily spring up, it is evident that this canal affords even "alone an efficient means of restoring our flag to its former place on "the seas. Such a domestic coasting trade would arise immediately, "for even the fishing vessels of both seaboards which now lie idle in "the winter months, could then profitably carry goods between the "eastern and western States.

"The political effect of the canal will be to unite closer the States "now depending upon railway corporations for all commercial and "personal intercourse, and it will not only cheapen the cost of trans-"portation, but will free individuals from the possibility of unjust

"discrimination. It will bring European grain markets of demand "within easy distance of our Pacific, and will give to the manufac- "turers on the Atlantic seaboard economical access to the cities of "China, thus breaking down the barrier which separates the princi- "pal manufacturing centres of the United States from the markets "of the vast population of Asia, and placing the Eastern States of "the Union for all purposes of trade midway between Europe and "Asia. In point of time the gain for sailing vessels would be great, "amounting, from New York to San Francisco, to a saving of "seventy-five days; to Hong Kong of twenty-seven days; to Shang- "hai of thirty-four days, and to Callao of fifty-two days."

An examination of the documents in the archives of the United States Government will show that it has not only been the unanimous policy of our greatest statesmen, but the earnest and deep-seated sentiment of our people, that European countries should not colonize any part of North or South America, and should not exclusively control the Isthmian crossing, whether it be by rail-road, canal or ship-railway. The occupation of the Panama Isthmus by an armed force last spring was made by the United States in virtue of a treaty concluded with New Granada (now the United States of Colombia,) in 1848. The express object of this treaty was to enable the United States, and not an European power, to protect the Panama Railway. The explicit wording of Article XXXV. of this treaty shows how important the subject was considered then, especially when it is remembered that our Government has uniformly and strictly adhered to the policy of non-interference in the affairs of other countries. It is as follows:

"And in order to secure to themselves the tranquil and constant "enjoyment of these advantages, and as an especial compensation "for the said advantages, and for the favors which they have "acquired by Articles IV., V. and VI., of this treaty, the United "States guarantee positively and efficaciously to New Granada, by "the present stipulation, the perfect neutrality of the before named "isthmus, with the view that the free transit from one to the other "sea may not be interrupted or embarrassed in any future time "while this treaty exists."

The only way to reduce to a minimum the danger of European complication on the American isthmus is for this Government to unite with Mexico in the encouragement and protection of an isthmian route at Tehuantepec.

It is not a sentiment only but a deep-seated policy established by

treaty precedent and the declaration of American statesmen of all parties, that any isthmian crossing between the Atlantic and Pacific shall be absolutely neutral and safe from interference; the transit-way to be held inviolate for the benefit of the commerce of all nations.

The great importance of an interoceanic communication, the advantages of the Tehuantepec Route, the established practicability of the Ship-Railway and the broad and statesmanlike policy to be followed by his administration, are clearly expressed by President Cleveland in his Message to the Congress of the United States, Dec. 8th, 1885, as follows:—

"The interest of the United States in a practicable transit for ships across the strip of land separating the Atlantic from the Pacific has been repeatedly manifested during the last half century.

"My immediate predecessor caused to be negotiated with Nicaragua a treaty for the construction, by and at the sole cost of the United States, of a canal through Nicaraguan territory, and laid it before the Senate. Pending the action of that body thereon, I withdrew the treaty for re-examination. Attentive consideration of its provisions leads me to withhold it from re-submission to the Senate.

"Maintaining, as I do, the tenets of a line of precedents from Washington's day, which proscribe entangling alliances with foreign States, I do not favor a policy of acquisition of new and distant territory or the incorporation of remote interests with our own.

"The laws of progress are vital and organic, and we must be conscious of that irresistible tide of commercial expansion which, as the concomitant of our active civilization, day by day, is being urged onward by those increasing facilities of production, transportation and communication to which steam and electricity have given birth; but our duty in the present instructs us to address ourselves mainly to the development of the vast resources of the great area committed to our charge, and to the cultivation of the arts of peace within our own borders, though jealously alert in preventing the American hemisphere from being involved in the political problems and complications of distant governments. Therefore, I am unable to recommend propositions involving paramount privileges of ownership or right outside of our own territory, when coupled with absolute and unlimited engagements to defend the territorial integrity of the State where such interests lie. While the general project of connecting the two oceans by means of a canal is to be encouraged, I am of opinion, that any scheme to that end to be considered with favor should be free from the features alluded to.

"The Tehuantepec route is declared, by engineers of the highest repute and by competent scientists, to afford an entirely practicable transit for vessels and cargoes, by means of a ship-railway, from the Atlantic to the Pacific. The obvious advantages of such a route, if feasible, over others more remote from the axial lines of traffic

between Europe and the Pacific, and, particularly, between the valley of the Mississippi and the western coast of North and South America, are deserving of consideration.

"Whatever highway may be constructed across the barrier dividing the two greatest maritime areas of the world must be for the world's benefit, a trust for mankind, to be removed from the chance of domination by any single Power, nor become a point of invitation for hostilities or a prize for warlike ambition. An engagement combining the construction, ownership and operation of such a work by this Government with an offensive and defensive alliance for its protection, with the foreign State whose responsibilities and rights we would share, is, in my judgment, inconsistent with such dedication to universal and neutral use, and would, moreover, entail measures for its realization beyond the scope of our National polity or present means.

"The lapse of years has abundantly confirmed the wisdom and foresight of those earlier Administrations which, long before the conditions of maritime intercourse were changed and enlarged by the progress of the age, proclaimed the vital need of interoceanic transit across the American Isthmus and consecrated it in advance to the common use of mankind by their positive declarations and through the formal obligation of treaties. Toward such realization the efforts of my Administration will be applied. ever bearing in mind the principles on which it must rest, and which were declared in no uncertain tones by Mr. Cass, who, while Secretary of State, in 1858, announced that 'What the United States want in Central America, next to the happiness of its people, is the security and the neutrality of the interoceanic routes which lead through it.'

"The construction of three transcontinental lines of railway all in successful operation, wholly within our territory and uniting the Atlantic and the Pacific oceans, has been accompanied by results of a most interesting and impressive nature, and has created new conditions, not in the routes of commerce only, but in political geography, which powerfully affect our relations toward, and necessarily increase our interests in any trans-isthmian route which may be opened and employed for the ends of peace and traffic, or, in other contingencies, for uses inimical to both. Transportation is a factor in the cost of commodities scarcely second to that of their production, and weighs as heavily upon the consumer. Our experience already has proven the great importance of having the competition between land carriage and water carriage fully developed, each acting as a protection to the public against the tendencies to monopoly which is inherent in the consolidation of wealth and power in the hands of vast corporations. These suggestions may serve to emphasize what I have already said on the score of the necessity of a neutralization of any interoceanic transit; and this can only be accomplished by making the uses of the route open to all nations and subject to the ambitions and warlike necessities of none."

CHAPTER III.

COMMERCIAL AND INDUSTRIAL FACTS SHOWING THE PARAMOUNT IMPORTANCE OF, AND IMPERATIVE NECESSITY FOR, AN ISTHMIAN CROSSING.

The London "*Times*" of August 21, 1884, treated this subject so broadly that we give the paragraph entire that relates to it:

"Looking at the ship-railway project from a broad and general "point of view, there can be little doubt that it is one which is "fraught with great results. This will be better realized when it is "remembered that the American isthmus separates about 100,000,000 "of the most enterprising, industrious and enlightened people on the "face of the earth, inhabiting the North Atlantic coasts of Europe "and America, from 600,000,000 who inhabit the Orient and the "islands of the Pacific. It is true that the sailing distances which "separate England from India, China and other Oriental countries, "have been greatly reduced by the Suez Canal; but these distances "are almost insignificant when compared with those which the ship "railway would annihilate. For instance, the greatest saving effected "by the Suez Canal between London and Calcutta is about 4,500 "statute miles, whereas the sailing distance by the ship railway from "London to every port on the Pacific coast of North America will "be lessened by nearly twice this great distance, or about 8,250 miles. "The Suez Canal brought London and Canton about 3,500 miles "nearer together by sea. The ship railway would save more than "three times that distance between the great American metropolis "and every port in British Columbia. The American isthmus and "the Cordilleras of North America constitute a narrow but almost "impassable barrier to the interchange of the manufactures and pro-"ductions of 40,000,000 of people in the Mississippi Valley and "Atlantic States, not only with those of 10,000,000 of their country-"men to the west of them, but with the others on the islands and "coasts of the Pacific who are seemingly their nearest neighbors. "The ship railway would give to these descendants of the British "Isles a sea route between their Atlantic and Pacific ports scarcely "a thousand miles longer than the railway between New York and "San Francisco, and it would give to the vast valley of the Mississippi "a gateway equivalent to the discharge of its mighty river directly "into the Pacific. A work designed to confer such great benefits "on the commerce of the world should commend itself with especial "force to this country, which is carrying more than 70 per cent. of "that commerce."

The writer, in an address before the Franklin Institute of Philadelphia, December 28, 1884, gave in detail the following commercial reasons for an interoceanic crossing:

"It is necessary now to glance at the internal commerce of the

"United States, because from that we can estimate what its foreign "commerce would be, if the barriers now obstructing it were "removed, and if the immense surplus products, agricultural, manu- "facturing and mineral, could be shipped at reasonable expense and "in reasonable time, to foreign countries needing our surplus pro- "ductions. During the year 1883, the railroads of the United "States transported over four hundred million tons of freight, valued "at $12,000,000,000. These goods if placed for transportation in "one freight train, carrying fifteen tons to the car, would require a "a train 175,000 miles long, or seven times the circumference of the "earth. In addition to this rail transportation there should be added "many millions of steamboat and coastwise tonnage, probably equal "to fifty per cent. of that transported by rail. While we are carry- "ing, year by year, these immense amounts of freight, the whole "foreign commerce of Europe is less than ten billions of dollars in "value.

"The Mississippi Valley has a commercial internal business, "by river and by rail, of over four billions of dollars. Galveston, "the seaport of Texas, has a tributary net work of railroads more "than six thousand miles in length. The increase of commerce of "the countries west of the United States, that is, those bordering on "the Pacific, has been one hundred and fifty per cent. in five years; "but on account of the impossibility of reaching this business we "have less than *four per cent.* of it—the remainder going to "Europe, via the Cape of Good Hope, the Suez Canal and Cape Horn.

"Our Pacific Coast—California, Oregon and Washington Terri- "tory, is especially adapted to the cultivation of cereals, particularly "wheat. The salubrity of the climate and the richness of the soil "reduce the cost of its production to a minimum. But on account of "the great length of the voyage by which the wheat and the flour of "the Pacific Coast reach Liverpool and other markets of the Old "World, it must compete, under great disadvantages, with the wheat "raised in India and Australia. A voyage of sixteen thousand "miles is necessary to place California wheat in the Liverpool "market. The freight per ton by sea is about $15.00. To haul it "across the continent by the transcontinental railway lines, would "cost $25.00 to $35.00 a ton to New York alone, saying nothing of "the transatlantic voyage."

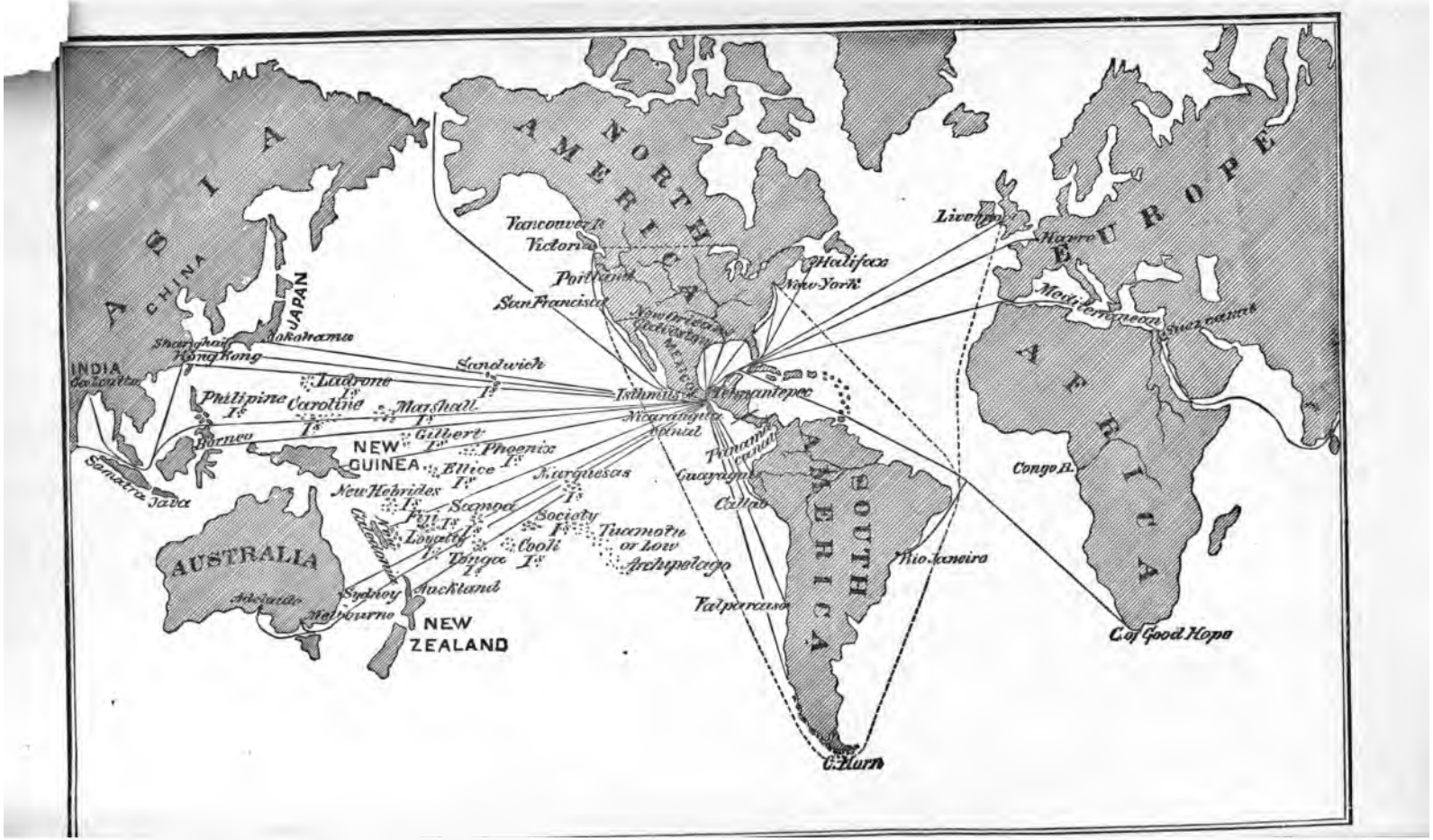
Another view of the same subject was presented in an address, by the writer, before the American Association for the Advancement of Science, August 26th, 1885, as follows:

"Forty-five millions of our people live east of the Rocky Mountains, and produce nearly all the manufactured goods of the country, which amount annually to the enormous total of over *five billion dollars* ($5,000,000,000) in value. Not being able to reach economically or promptly the countries that have need of these manufactured articles, we export but *two per cent.* of them, and therefore we cannot compete with those countries of Europe which also manufacture them, and which by the Suez Canal are placed much nearer to those markets. Special attention is called to the unfortunate position of the Mississippi Valley and its seaports on the Gulf; with only eight hundred miles between them and the Pacific, they cannot reach its markets except by a voyage around Cape Horn, which absolutely prevents all commercial intercourse with them. Our whole eastern and southern coast can send its products *Eastward*, but to the *Westward* is an impassable barrier, and Westward are six hundred million people offering their rich treasures to commerce and civilization. The dwellers on the west of South America, Mexico and our own Pacific coast, although seemingly our nearest neighbors, are practically removed farther from us than the East Indies are by way of the Suez Canal.

"The over-sea commerce of the globe is now upward of fourteen billion dollars, and is increasing at the rate of *seventy-five* per cent. every decade; so that, if ten years ago it was important to solve the isthmian problem, it is vastly more important to-day, and will be still more so ten years hence."

There is an imperative necessity for a shorter and less expensive maritime route than now exists from our Pacific coast to the Atlantic markets of this country and Europe. The Suez Canal has given to India such an immense advantage in the exportation of cereals to Europe, that this important product of the Pacific coast will soon be without an available market; but 8000 miles saved in distance, and two months and a half in time, will more than restore the advantage we had before the opening of the Suez route. Another important and much needed factor in the development of the Pacific coast States is the immigration of a hardy, industrious and assimilating European population. A short and inexpensive maritime route for passengers from European ports to San Francisco and Portland will induce agricultural emigrants to seek the Western coast, from which they are now practically excluded by the excessive cost of transportation. The prosperity of the Pacific States will also tend to the development of that great railway system which penetrates to

the heart of the continent. Water-ways parallel with railways have not checked but have actually promoted the development of the latter. The all-water route to the Atlantic seaboard from the Great Lakes has, no doubt, tended to the development of the Great Trunk Line systems that are parallel to these water-ways. The Mississippi River, the great Water Trunk Line north and south, has stimulated and developed the railroad systems that parallel it from St. Louis, Chicago and St. Paul to New Orleans, and the same is true in reference to Long Island Sound and the Atlantic Coast. A short all-water route from the Hudson to the Golden Gate will develop and enrich the whole country bordering on the two oceans, and increase the business of the transcontinental railways, and enrich them. The opening of the Gulf ports to the Pacific markets will benefit the whole interior country also, and even to the remote lakes of the north and the enterprising cities upon their shores, will be felt the pulsations of the new life which a maritime transit-way at the Mexican Isthmus will infuse into the commerce and industries of our entire country. The joining of the 10,000 miles of Atlantic coast line with the 10,000 miles on the Pacific will multiply the coastwise commerce of the United States, now already immense, beyond the expectations of the most sanguine advocate of an isthmian crossing.


ASIA
CHINA
JAPAN
Yokohama
Shanghai
Hong Kong
INDIA
Philippine Is.
Ladrone Is.
Caroline Is.
Marshall Is.
Borneo
NEW GUINEA
Gilbert Is.
Phoenix Is.
Ellice Is.
Sandwich Is.
Marquesas Is.
Society Is.
Tuamotu or Low Archipelago
Cook Is.
Tonga Is.
Samoa
Fiji Is.
Loyalty Is.
New Hebrides
Sumatra
Java
AUSTRALIA
Adelaide
Melbourne
Sydney
Auckland
NEW ZEALAND
NORTH AMERICA
Vancouver I.
Victoria
Portland
San Francisco
New Orleans
Mexico
Isthmus of Tehuantepec
Nicaragua Canal
Panama Canal
Halifax
New York
SOUTH AMERICA
Guayaquil
Callao
Valparaiso
C. Horn
Rio Janeiro
EUROPE
Liverpool
Havre
Mediterranean
Suez Canal
AFRICA
Congo R.
C. of Good Hope

CHAPTER IV.

SUPERIOR ADVANTAGES OF THE TEHUANTEPEC ISTHMUS — COMMERCIAL, CLIMATIC, CONSTRUCTIVE AND STRATEGIC.

It will be seen by an examination of the map of the world (Plate II.) that the American isthmus is about fifteen hundred miles in length, in an air line, and that the distance from the Tehuantepec isthmus to Panama is about twelve hundred miles, and to Nicaragua about eight hundred. It will also be noticed that the Tehuantepec Isthmus is nearest to North America. It may be generally assumed that that crossing of the American isthmus which is nearest to the axial line of commerce will offer the shortest routes. That line may be assumed to be drawn through Hong Kong, San Francisco, New York and Liverpool. The table of distances on pages 63–65, will show how much shorter is the route *via* Tehuantepec on nearly all of the main lines of commerce. The principal purpose of this country in opening interoceanic communication for our merchant marine is to form a closer commercial union of the ten thousand miles of our eastern, with the ten thousand miles of our western coast; to shorten the immense distance of sixteen thousand miles that must be traversed by the commerce of our Pacific coast on its voyage to New York or Liverpool, and to obtain the shortest and most economical route for freight and passengers from the Old World, as well as from our own Atlantic coast, to our Pacific States and British Columbia. A crossing at Tehuantepec for ships will accomplish this better than any other location can possibly do. For an ordinary sized steamer it will save, over the Panama route, at least one thousand dollars on every trip; and, on account of the longer time required to pass the ship through the Nicaragua Canal, the saving over that route will be nearly as great. Commodore Shufeldt, United States Navy, in 1871, in an official report of his survey of the Isthmus of Tehuantepec, said:

"Each Isthmus rises into importance as it lies nearer to the "centre of American commercial interests, and the intrinsic value "of this eminently national work ought to be based upon the "inverse ratio of the distance from that centre."

The Tehuantepec Isthmus has important advantages in the superior nautical conditions which prevail there. Commander Selfridge, whose great familiarity with the coasts of the American Isthmus gives weight to his opinion, stated as follows, in an official report on the Darien Ship Canal:

"Lying near the equator, but generally a little north of it, is a "belt some four or five degrees wide, of calms, rains and light baf- "fling winds, that separates the wind systems of the north Pacific "from those of the south. Its average northern limit may be placed "at 8° north and its southern at 3° north, but both are very vari-

"able. This is often spoken of as a 'calm belt,' which term is "calculated to mislead one as to the nature of the weather to be "expected within these limits. Neither does the term, 'region of "variable winds,' appear satisfactory, as it does not express the "peculiar character of the weather. '*Doldrums*' seems to be the "correct word, for although it may be as some say, 'uncouth,' it is "the only single word that conveys to the mind of the seaman all "that can be expressed by saying 'a region of calms, squalls, light "baffling winds, and storms of wind and rain.'" *

That eminent authority on the physical geography of the sea, Lieut. M. F. Maury, says, after describing the winds and currents on each side of the American Isthmus: "You will observe at a glance "that the Isthmus of Panama, or Darien, is, on account of these "winds and calms, in a purely commercial point of view, the most out "of the way place of any part of the Pacific coast of inter-tropical "America." †

He stated in a letter written in 1866, as follows:

"I have spoken about the calm belt about the equator—Panama "is within its range. * * * It is difficult to convey to one who "has never experienced these calms an idea of the obstinacy with "which they vex navigation. We are all familiar with calms at sea "which last for a few hours or even a day, but here they last for "days and weeks at a time. I have known vessels going to or from "Panama to be detained by them for months at a time. * * * "On one occasion the British admiralty wishing to send one of their "sailing vessels into the Arctic Ocean from Panama in time to save "the season had her towed by a steamer through this calm belt and "carried seven hundred miles out to sea before she could find a "breeze. * * *

"These remarks apply to the approach and departure by sea to or "from the Pacific terminus of any route across the Isthmus of "Panama or Darien, and even with greater force to the Atrato and "others on the South American side of Panama. In short, the results "of my investigations into the winds and currents of the sea and "their influence upon the routes of commerce, authorize the opinion "which I have expressed before and which I here repeat, namely, if "nature, by one of her convulsions, should rend the continent of "America in twain and make a channel across the Isthmus of "Panama or Darien as deep, as wide, and as free as the Straits of "Dover, it would never become a commercial thoroughfare for sail-"ing vessels, saving the outward-bound and those that could reach "it with leading winds."‡

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* House Mis. Doc. No. 113, 42d Cong., 3d Sess., p. 231.

† From testimony of Lieut. Collins, U. S. N., before House Com. on Inter-oceanic Canals, July 28, 1880, page 41 of testimony.

‡ Mis. Doc. No. 66, 46th Congress, 3d Session, page 41.

Capt. Silas Bent, the well known nautical expert, stated the following before the Merchants' Exchange of St. Louis:

"Mere statements of the difference in miles is a very inadequate "measure of the difference in time that would be occupied by sail- "ing vessels in making these several passages, and when we consider "that three-fourths of the ocean commerce of the world is carried in "sailing vessels, you can see what an important factor this question "of *sailing-time* becomes in the solution of the problem before us.

"The northeast trade winds which extend across the Atlantic are "so broken and interrupted when they encounter the West India "Islands, that they never penetrate the Caribbean Sea; but the "northwest portion of them, however, do extend into the Gulf of "Mexico, and often so far down as to reach well toward Tehuante- "pec, so that whilst in the Gulf winds are always found, yet the "Caribbean Sea remains a region of almost relentless calm.

"Nor is this all, for the mountain ranges, extending the length "of the Isthmus of Panama and through Central America, offer a "still more formidable barrier to the passage of these winds, thus "throwing them still higher into the upper regions of the atmo- "sphere, and extending these calms far out into the Pacific Ocean, "on the parallel of Panama, with lessening width, for fifteen or "eighteen hundred miles to the northwest, along the coast of Cen- "tral America.

"This whole region of calms, both in the Caribbean Sea and in the "Pacific Ocean, is so well known to navigators that sailing vessels "always shun it, if possible, though they may have to run a thousand "miles out of their way to do so.

"This absence of wind of course leaves this vast area exposed to "the unmitigated heat of a torrid sun, except when relieved momen- "tarily by harassing squalls in the dry season, and by the deluging "rainfalls of the wet season. With these meterological facts in "view, let us now suppose that the Lesseps Canal at Panama, and "the Eads Railway at Tehuantepec are both completed and in run- "ning order; then let us start two sailing ships, of equal tonnage and "equal speed from the mouth of the Mississippi, with cargo for "China, one to go by the way of the Panama Canal, and the other "by the way of the Tehuantepec Railway, and I venture to affirm "that by the time the Panama vessel has cleared the canal and floats "in the waters of the Pacific, the Tehuantepec vessel will have scaled "the Isthmus and be well on to the meridian of the Sandwich "Islands; and that before the former vessel can worry through the "fifteen or more hundred miles of windless ocean before her, to "reach the trade winds to the westward of Tehuantepec, the latter "will have sped five thousand miles on her way across the Pacific, "and be fully thirty days ahead of her adversary. For it is a fact "worth mentioning here, that the strength of the northeast trade "winds in the Pacific, as well as the maximum strength of the north- "ern portion of the great equatorial current in that ocean, are both "found on or near the parallel of latitude of Tehuantepec, the

"former blowing with an impelling force to the westward of ten or "twelve miles an hour, and the latter with a following strength of "three or four miles per hour."

It has been stated by those who advocate an interoceanic crossing at Panama, that it really makes very little difference to the commerce of the world, whether the route is favorable or not to sailing vessels, for the alleged reason that steamships are rapidly taking their place. The facts given in the report of our Commissioner of Navigation, Mr. Jarvis Patten, for 1884, pp. 22 and 23, controvert this statement:

"The American merchant marine of the present time, although it "has not in later years kept pace with that of Great Britain, is sec- "ond only to hers.

"Notwithstanding the disadvantages that American shipbuilders "have had to contend against, the high character of their vessels "has been maintained. Our wooden ships are probably the best "and safest vessels afloat. * * *

"'We are apt to talk as if we had no ships,' said Hon. W. P. "Frye, in a speech to the Senate April 30, 1884, 'and you would 'judge from an ordinary discussion in Congress that there was no 'such thing as an American ship to-day. Why, Mr. President, we 'have the finest coastwise trade in size, in ships, in material, in men, 'in discipline, in comfort, in convenience, in prosperity that there is 'in the whole world,' and the Senator might with equal truth have "said the same of the fine fleet of sailing ships engaged in the Cali- "fornia wheat trade. When the guano trade, which gave employ- "ment to a large number of ships for a period of twenty years, col- "lapsed with the outbreak of the Peru-Chili war, our vessels went "into the grain trade that had been springing up between our Pacific "ports and Europe. This trade, which has since grown to great im- "portance, employs the largest and best-equipped fleet of wooden "ships in the world. * * * *

"The wood sailing ships of this country are thought to surpass 'any others afloat in point of safety, and it is a mistake to accept "the opinion that the day of wooden ships is entirely past. Two- "thirds of the tonnage of the world is probably still composed of "wooden vessels, while their numerical preponderance is much "greater, notwithstanding the fact that for screw steamers and many "other kinds of craft iron possesses certain advantages.

* * * * *

"In round numbers the total of our sea-going marine was on June "30, 1884: Vessels, *6,636;* tons, *3,700,404.* Of this number, "*422*, of *601,186* tons, were steamers, and *the rest sailing vessels.*"

The Report of the Commissioner for 1885, shows an *increase* during the year of **60** sailing vessels, and a *decrease* of **67** steamships.

An early transit-way for ships at Tehuantepec will do much to solve the important problem now before the country so prominently, of promoting our merchant marine and the shipping interests of the United States. It will assist very materially in restoring us to our proper place among the commercial nations of the world. The importance of these interests was eloquently stated by the Hon. Nelson Dingley, Jr., in a speech in the House of Representatives, April 25, 1882, in which he used the following language:

"The efforts of England to control the ocean carrying trade ought "to arouse the American Congress and people to the importance of "our shipping interests. This is a question which affects the "interior as much as the seaboard, the West as much as the East, "the South as much as the North. It is not a local, but a national "question.

"It involves the inquiry as to whether we will save to our own "people the ship-building industry, which employs ten thousands of "workmen, and distributes millions of dollars; whether we shall "retain a due share of $100,000,000 which we annually pay for ocean "transportation, with all the avenues of employment which it would "open; whether we shall open up wider markets for American pro-"ducts in China, Japan, South America and the Orient."

According to Mr. Patten, we can build wooden sailing ships cheaper and better than any other nation in the world. But it is certain that an interoceanic crossing at Panama (because of "the Doldrums" or calm belt) will not only prevent their construction in the future, but will drive from the seas most of the sailing ships we now possess, if we do not open up a route for them at Tehuantepec.

It is important, considering the unhealthiness of several parts of the Isthmus, that, other things being equal, that location should be selected which has the greatest climatic advantages. The testimony in favor of the superiority in this respect of the Tehuantepec Isthmus is overwhelming. Mr. J. J. Williams, whose valuable work on the Tehuantepec Isthmus is considered an authority everywhere, from his long experience as a civil engineer on the Isthmus, states as follows on page 172 of his work entitled "The Isthmus of Tehuantepec:"—

"The conviction in the minds of those engaged in drawing up this "report, and one founded on a residence upon the spot, is, that the "climate of the Isthmus is a mild and healthy one, favorable to "longevity, and free from many diseases incidental to more tem-"perate latitudes. The health of those engaged on the survey was "unusually good during their entire stay; and although frequently by "accidents wetted to the skin and remaining in wet clothes the whole "day, and this occurring on successive days, with limited food at "long intervals, yet none suffered in consequence—a strong proof "that their health was due to the favorable climate.

"Compared with other places, selected for forming a junction

"between the two oceans, this Isthmus has peculiar advantages. "With less alluvial land at the sea-level, it is more healthy than San "Juan de Nicaragua, and from its more northern latitude, its mean "annual temperature is less than that of Nicaragua or of Panama. "The latter place has, indeed, a temperature and climate truly tor- "rid, and partaking more of the character of a continent than of an "island, which latter is the peculiarity of the position of this por- "tion of Mexico."

His statement is supported by the report of Dr. Kovaleski, who was surgeon of the party. The following are extracts from his voluminous report:

"I took particular care to inquire among the inhabitants, what "were the diseases from which they mostly suffered, and how "strangers settling among them were affected, and I ascertained "beyond doubt, that not only Minatitlan, but the whole plain of the "Coatzacoalcos River, wherever inhabited, was a remarkably healthy "country. * * *

"I met at Minatitlan several individuals who formed a part of the "French colony, and who had resided there for twenty-two years; "they all assured me that they enjoyed uninterrupted health. The "appearance of the natives proves the country to be healthy, and "our small party had no reason to complain of sickness during its "stay. * * *

"The plain of the Coatzacoalcos River, flat and low, with an "extremely fertile alluvial soil, covered with thick forests, intersected "by many rivers and here and there subject to inundation, although "the least healthy, yet enjoys a high degree of salubrity, and no fears "need be entertained, as proved by the experience of the French "emigrants, for those who may in future settle permanently in "this region, and much less so for those who may cross it as trav- "ellers.

"The region of hills and mountains is as healthy as the most "salubrious portions of Europe; full of romantic scenery, it is even "now highly attractive, and will, in progress of time, when inhabited "by an enterprising and laborious population, become one of the "most beautiful spots on the earth.

"Last, comes the plain of Tehuantepec, nearly as healthy as the "hilly region, although warmer, presenting all the characteristics of "a healthy tropical climate.

"All these three regions together form a broad surface of country "from the Gulf of Mexico to the coast of the Pacific, of a great "variety of resources and of remarkable healthiness, a feature "peculiar to the Isthmus, as the lands on both of its sides are very "unhealthy; such as Vera Cruz and Tabasco on the Gulf, Acapulco, "Huatulco, and the coast of Guatimala on the Pacific shore. This "peculiar and exclusive salubrity of the Isthmus, is, in my opinion, "chiefly due to its configuration, which forms as it were a gate, "walled on both sides by heavy masses of mountains, through which

"pass currents of air, that render the country they traverse per-
"manently salubrious."

Mr. Martin Van Brocklin, who spent two years on the Isthmus as Chief Engineer of the Tehuantepec Railroad and one year as Resident Engineer of the Ship-Railway, states in an official report to the President of this Company as follows:

"The country through which the line passes has a fine salubrious
"climate, with the exception of the immediate valley of the Coatza-
"coalcos River, where malarial fevers are prevalent for a portion of
"the year. By reason of the peculiar topographical formation of
"the Isthmus, there is an almost constant interchange of air currents
"between the two Oceans. The inhabitants are a robust and health-
"ful people." * * *

The writer's own observations on the Isthmus, and the experience of engineering parties sent there by him, confirm the opinions just given. These engineering parties, composed mostly of unacclimated young men from the northern portions of the United States, went to the Isthmus in March, at the beginning of the tropical rainy season, worked continuously for seventeen months in the woods and on the table-lands and plains of the Isthmus, exposed to hardships and unprotected from the weather; no case of sickness occurred among them, and they came back to the United States, after completing their work, in robust health.

In proof of the above is offered an extract from the report of Mr. Deming J. Thayer, civil engineer in charge of our surveys for ten months, and who has spent several years on the isthmus and in the states of Colombia:

"Hitherto it has been erroneously supposed that engineering par-
"ties could not remain in the field during the rainy season; that the
"increase in hardships would result in sickness among the men
"employed, and this, in connection with the time lost when raining,
"would render desirable progress impossible. Our experience
"during an entire and unusually hard rainy season disproves this
"supposition. No sickness showed itself among assistants or men,
"little or no time was lost, and progress was nearly as rapid as
"during the dry season."

Another advantage of great importance is the good harbors that exist on each side of the Isthmus, the entrances to which can with inexpensive works be deepened to any required depth. On the Atlantic or Gulf side of the Isthmus there is a natural land-locked basin, which has a depth of from forty feet to sixty feet. It is several miles in length, of ample width, and in which an immense fleet can lie at anchor in safety. On the Pacific side two beautiful lakes, comprising two hundred and fifty square miles with depths of twenty-two feet, connect with the Pacific Ocean by a natural passage-way. The deep water of the Ocean approaches within twelve hundred

feet of the shore line. Mr. Williams states as follows, in reference to the harbor on the Atlantic side :

" As soon as the bar is crossed and the ascent of the river com-
" mences, it widens and deepens, and at seven miles from the Gulf,
" the lead shows a depth of forty feet, which is preserved for some
" distance. * * * The superior advantages offered by this
" stream as a safe and convenient harbor for ships, early attracted
" the attention of the Spanish conquerors. Cortez, in his official
" despatches to the Emperor, Charles V, speaks of the importance
" of this river as furnishing the best harbor to be found on the Gulf
" coast of Mexico."

The voluminous report of Mr. Williams gives abundant evidence that the country is well adapted for the construction of a Ship-Railway, and that the materials are conveniently at hand for constructing the works ; and the report of Mr. Martin Van Brocklin, under whose immediate direction the first complete instrumental survey across this isthmus was made, gives conclusive evidence that the railway can be built on solid ground, and that excellent materials are found near at hand. The following quotations are from his report to the President of this Company :

" Through a distance of thirty-five miles from Minatitlan, the line
" is in an extensive alluvial plain, composed in all its lower portions
" of a heavy tenacious clay. In the higher portions, and in the small
" ridges that are encountered, a clay loam is found, with an occa-
" sional deposit of sand.

" The firm and tenacious character of the material upon which
" the road-bed will rest, and of which it will be composed, will
" secure the railway from any injurious effects of water. Leaving
" this plain, the line enters an undulating table-land, extending to a
" point fifty-five miles from Minatitlan, where it leaves the valley of
" the Coatzacoalcos River and follows a succession of broad valleys
" formed by the Jumuapa, Sarabia, Malatengo and Chichihua rivers ;
" between these valleys there are extensive table-lands, with no high
" or prominent dividing summit between them, but they are inter-
" spersed with isolated hills and detached ranges from one to five
" hundred feet in height, the whole forming an extensive interior
" basin, having a gentle inclination towards the summit, and
" bordered on its eastern and western sides by irregular mountain
" ranges, spurs of the main Cordillera that runs through the entire
" continent, and which makes at this point one of the most marked
" depressions to be found in its whole length. From this basin the
" line passes through a valley formed by a stream called the Pozo de
" Agua, to the plains of Tarifa, an elevated level plateau six miles in
" extent. Crossing these plains, the line reaches the Portillo de
" Tarifa, the lowest and also the most accessible of the many passes
" through this general depression in the main mountain chain.
" From the Portillo de Tarifa the line descends to the Pacific plains
" (reaching them 118 miles from Minatitlan) by a uniform grade,

"following a succession of valleys through the intervening foot-"hills. These valleys are generally narrow, having very abrupt "slopes on their sides. Fortunately the line can be kept near the "bottom of the valleys, avoiding any difficult or questionable class "of construction. The heaviest excavations will be in cutting "through spurs of the hill sides, or through divides between adjacent "valleys. Across the Pacific plains the line can be given almost any "desired direction, the surface being remarkably even and uniform "in character." * * * "Many varieties of valuable timber are "found, very durable in character, and suitable for either permanent "or temporary work in construction, throughout the entire line, with "the exception of about twenty miles at each end of it.

"Good building stone is found near the line at short intervals "after leaving the valley of the Coatzacoalcos River. Granite, "limestone, sandstone and quartzite are among the varieties of stone "available for purposes of construction.

"The principal rock cuttings to be encountered near the summit "will be in a clay slate formation, limestone appearing at a lower "elevation, and granite in the higher ranges on each side of the "line." * * * "A careful instrumental survey of the bar at the "mouth of the river shows that there is at ordinary tide, fifteen "feet of water over it. Surveys and soundings made during the "last thirty years give conclusive evidence that this bar has changed "very little during that time. Borings to the depth of twenty-six "feet encountered no other material than sand and clay, much the "larger portion being sand; a stratum of clay was found at the "bottom of the borings. This bar has a striking resemblance to "the bar at the mouth of the South Pass of the Mississippi River, "except that it has less than one-fourth the distance across it, from "twenty-six feet depth of water on the inside to the same depth on "the outside, and it can be deepened by the same methods that "gave such remarkable results at the mouth of the Mississippi "River."

Another important consideration is the strategic advantages which the Isthmus of Tehuantepec has over any other possible route. It is located nearest to the United States; it is in the Republic of Mexico, the strongest republic, next to the United States, on the American continent, and connected with us not only by close political and social ties, but also commercially by lines of railroads built and building from our country into and through it, and by several steamship lines to its ports in the Gulf and on the Pacific.

The Atlantic terminus of the ship-railway is in the Gulf of Mexico, whose approaches from the Atlantic at the Florida Straits and the Straits of Yucatan, can be easily defended by our navy in case of war; enabling us to maintain uninterrupted communication between all of our Gulf ports and the Ship-Railway, even though every Atlantic port should be blockaded and the enemy's cruisers infest the high seas. The harbor at the Gulf can be thoroughly defended by inexpensive fortifications on the high lands which rise immediately

above the entrance channel, and by torpedoes. Equally favorable conditions for defense exist on the Pacific. From these facts it is evident that, if Mexico and the United States unite to protect this transit-way, no other power or powers could successfully interfere with it.

In a pamphlet written by Mr. Alexander D. Anderson, on the Tehuantepec Ship-Railway, in 1884, on page 11, the strategic advantages are also stated as follows: "The railway system of the "United States, which now amounts to 125,000 miles, has, during the "past year, been extended to the City of Mexico by the completion "of the Mexican Central road from El Paso to the City of Mexico. "A second line, the Mexican National, is already half complete "between Laredo and the City of Mexico, and three other lines are "projected from the Rio Grande to the Mexican capital. These five "lines are to be prolonged southward to Tehuantepec by a line "already projected," and now, in 1885, being built by the Mexican Government, "thereby placing that Isthmus within easy reach of "the troops of the two sister republics, should they ever have "occasion to defend it. * * *

"By water, also, the Isthmus is equally accessible to the troops of "Mexico and the United States by steamers through an inland sea "which may easily be closed at the two passes between the Atlantic "and the Gulf. These remarkable advantages as a defensive point "may be seen by a glance at the Map of the World. It is in this "respect in marked contrast with the Isthmus of Panama or Nicara-"gua which would be exposed to attack."

CHAPTER V.

THE SHIP-RAILWAY, ITS PLANS AND PRACTICABILITY.

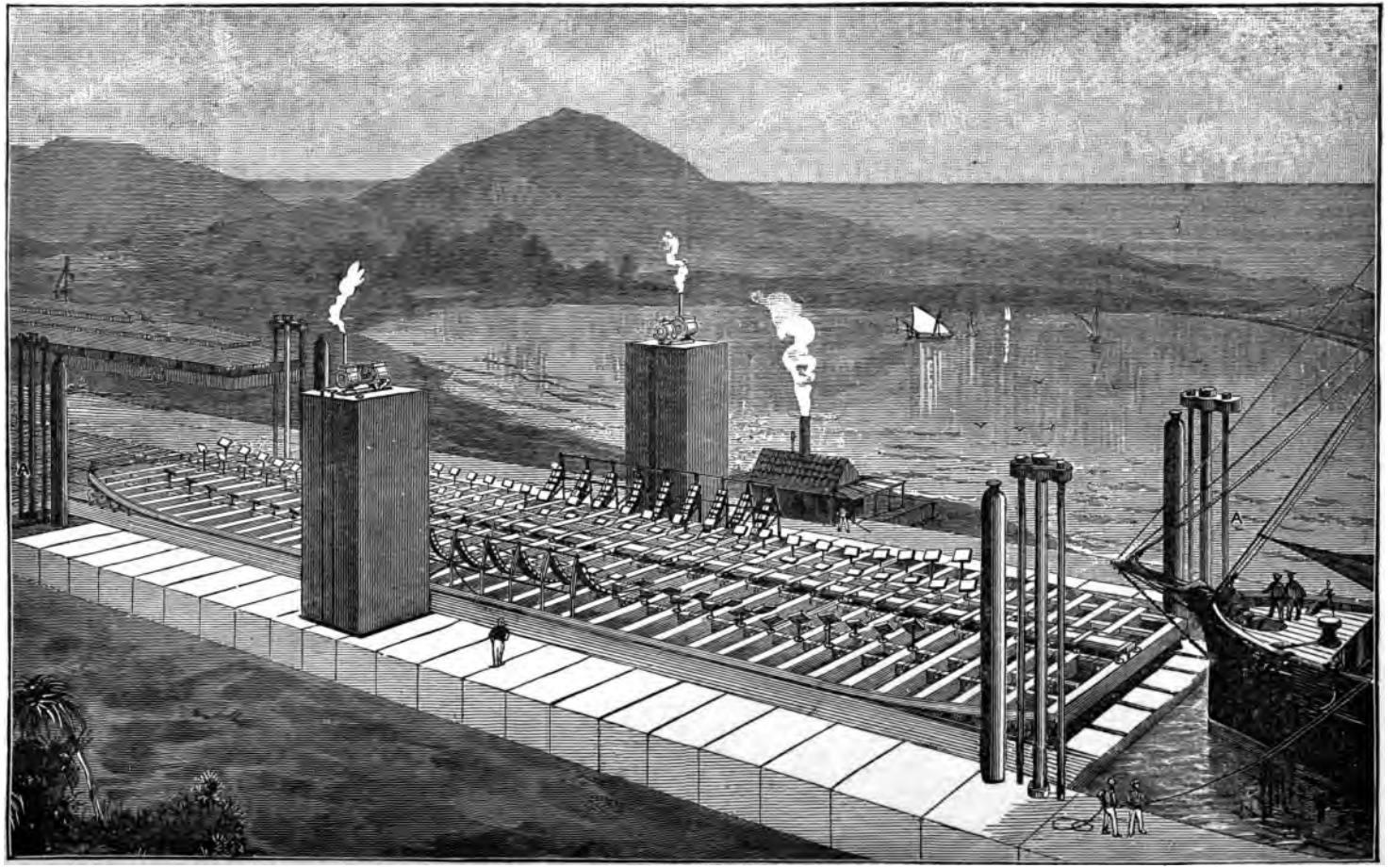
Many plans and projects have been brought forward for transporting vessels through or over the American Isthmus at various points, but until recently these plans have all contemplated artificial water channels. It was left for Mr. James B. Eads, after accomplishing the important work of opening the mouth of the Mississippi River to commerce, to propose and develop the plan of a ship-railway across the Isthmus of Tehuantepec. The important advantages of every nature stated in the previous chapters, together with the fact that an artificial water channel, either at sea level or by means of locks, would be altogether too expensive, were the reasons for the inception of the ship-railway.

The following description of the Ship-Railway was written by Mr. Eads, for "JOHNSON'S UNIVERSAL CYCLOPEDIA," (Revised Edition, pp. 252 to 256 :)

"After the publication, in 1879, of the estimates made by the Ship-Canal Convention which met, at the solicitation of Count de Lesseps, in Paris, the writer was led to investigate the practicability of the transit of loaded merchant-ships of the largest class by railway, to ascertain if a more economic method of transit than by canal could not be thus secured. It was generally known that the transportation of sea-going craft overland had been accomplished at the Isthmus of Corinth by the Athenians, 400 B. C.; that in the Middle Ages the Turks had transported ships of war in a similar manner; that a hundred years ago Swedenborg had carried three vessels of war across one of the peninsulas in the Baltic; that before the construction of the Suez Canal was commenced a ship-railway was proposed in lieu of it by Brunlees and Webb, two English engineers of note; that they had also in 1872 proposed and made plans for the construction of a ship-railway across Central America for ships of 1200 tons burden; and that, in 1875, Mr. H. G. C. Ketchum proposed a ship-railway across the Isthmus of Chignecto, between the Bay of Fundy and the Gulf of St. Lawrence, for vessels which would weigh, with cargo and machinery, about 2000 tons. Hence the idea of transporting ships by rail is not a new one. The plans hitherto proposed for this purpose did not contemplate, however, the handling of the largest merchant-ships. Crude estimates of the cost of the practical devices for this method soon gave assurance of great economy, in both money and time, in favor of the ship-railway. Further studies led to such improvements in the carriage on which to transport the ship, and the docks necessary to place it on the carriage and railway, as assured the absolute safety of the largest loaded ship during transit."

* * * * *

"The methods for raising, hauling and handling vessels, evolved from five years' study of the subject, will now be given. At each terminus is excavated a basin leading on the one side from the river, and on the other from the lake, to a dock, which will be walled on the sides and on one end either by masonry or by creosoted timber. In this dock will be placed a pontoon, which, like an ordinary lifting-dock, will be capable of raising the vessels (Plate III.). This pontoon will be made of steel plates, with bulkheads athwartships and fore and aft, so as to render it strong enough to support the weight, when out of the water, that it has to carry. Its size will be about 450 feet in length, 75 feet in width, and from 12 to 15 feet in depth. There will be built upon it, on each side, a water-tight tower whose top will stand above the surface of the water when the pontoon is submerged and resting on the bottom of the dock. The pontoon is sunk by opening sluice-gates; these sluice-gates are in its sides, and are operated from the top of these towers. It is raised by means of powerful pumps, which withdraw the water from the pontoon and discharge it into the surrounding dock or basin. These pumps are to be sufficiently powerful to raise the pontoon, with a vessel upon it, in from 15 to 20 minutes. It is guided in its vertical movement by large anchor-rods, which are secured in the foundations of the dock. These rods pass freely through the pontoon, but are separated from its water-spaces. The heads of these guiding-rods prevent the pontoon from rising above a certain level, and also resist its buoyancy when the vessel has been run off of the pontoon on to the railway. In order to lift a vessel without injury to itself and to place it upon a cradle or carriage for transportation without any possible injury to this carriage, it is necessary to distribute or equalize the weight of the vessel so as to bring no more weight upon one part of the carriage than upon another. A vessel has not the same weight per unit of its length throughout its whole extent, but, being a girder capable of resisting the flexures and bending moments which it must necessarily meet in its voyage on the ocean, it is capable of resisting, without injury to its structural integrity, this necessary equalization. In fact, when the vessel is in its natural element—smooth water—it is not equally borne by the water per unit of its length, from the fact that certain parts of the vessel are more buoyant than other parts. For instance, the bow and the stern of a steamer, or of any craft, have a tendency to droop, and it is often the case that after a vessel has been launched the ends of the keel are found to be below its central part. This equalization is accomplished by a series of hydraulic rams, or presses, which are built into the pontoon, and are founded upon a second deck about 6 feet below the main, or upper, deck of the pontoon. These rams are arranged in longitudinal and transverse lines, which are spaced in each direction about 7 feet apart. The combined or total area of the rams in any one transverse line is exactly equal to the combined area of every other transverse line. There being seven rams in one of these transverse lines in the midship section of the vessel, their area, if combined into one ram, would be exactly equal to the one ram under the bow or the stern of the vessel. As we approach toward



the bow or the stern from the centre there are five rams in a transverse line; as we approach still nearer to the bow or the stern there are three rams in each; and under the bow or the stern there is only one ram for each 7 feet of the ship's length. These rams are all connected by means of water-pipes, through which pressure is applied to the whole system of rams by means of a hydraulic pressure-pump placed on the top of the towers on the side of the pontoon. These rams have a vertical movement of 7 or 8 feet. When the principle of hydrostatic pressure is understood, it will be seen that any mass, whatever may be its shape, that rests upon this system of hydraulic rams when they are under pressure, will be equally borne throughout its whole extent, providing it has a bearing upon all the rams in the system. In the case of a vessel, either a sailing-ship or a steamer, this equalization is so perfect that the excess of weight in the central portion of the vessel when she is loaded will be taken up by the lines of rams toward the bow and the stern, which have immediately over them a weight less than that which they are able to sustain. This system of rams is grouped by means of valves, so that, if necessary, a greater pressure can be brought to bear upon one part of the vessel than upon another. In practice there would be a large number of valves, so that the system could be applied to different sizes and shapes of vessels as each might require. It will be seen, therefore, that when the vessel rests upon this system of rams she is water-borne; for she is resting upon so many columns of water under pressure, which equalizes the weight of the vessel by a process which is similar to that employed by Nature herself when the vessel is resting in her natural element. Attached to the water-pipes is a pressure-gauge, which will serve to show the exact weight of the mass borne on the system of rams.

"As a body floating under water has no stability, the pontoon which raises and lowers the vessel has none when wholly under water. As it will not always be possible to bring the centre of gravity of the vessel fore and aft directly over the centre of the pontoon, there will be a tendency for the pontoon to come up out of level if there is more weight upon one end of it than upon the other. To obviate this the pontoon is balanced, not by water let into the compartments, as is the case with a balance-dock, but by mechanical appliances called 'hydraulic governors.' (See Plate III., A. A.) These governors are located at the four corners of the pontoon, and at other points along the sides of the pontoon if in practice it should be found to be necessary. They consist of plungers working in cylinders. The plungers are attached to the pontoon, and the cylinders to the dock walls. On each corner there are an inverted cylinder and an upright cylinder. One upright and one inverted cylinder on the diagonal corners are connected with each other by means of pipes. The cylinders and the pipes are water-tight, and are filled with water. Now, if there is, say, 100 tons more weight upon one end of the pontoon than there is upon the other end, one-half of this will be borne by each of the two plungers secured to the heavy end of the pontoon, and there will be brought upon the water in each of the two inverted cylinders secured to the dock

walls at that end, a weight of 50 tons. The pressure due to this weight is immediately transmitted through the pipe to the upright cylinder on the diagonal corner at the other end of the dock, and the water in this cylinder instantly reacts with a 50-ton pressure as a plunger upon the metal plunger in the cylinder, and thus compels this corner of the pontoon to go down with the same velocity and to remain at the same level as the diagonal corner of the pontoon with which it is connected. If the excess of weight be at the other end, this action is reversed. By this means the pontoon is made to rise and fall in a perfectly level plane, and consequently is always so balanced as to work freely upon the guiding-rods. A pressure-gauge attached to the governor-pipes will indicate the amount of excess of weight on either end of the pontoon. If it is too great for the governors to balance with safety, or for the wheels at that end of the carriage, the pontoon would be lowered and the position of the vessel shifted. On the deck of the pontoon and between the longitudinal lines of rams are laid the rails for the carriage which is to transport the vessel. These rails are six in number and constitute three ordinary gauge-tracks, each 4 feet 8½ inches. The outer rails are 29 feet apart between gauge-lines. The carriage (Plate V.) to transport the vessel is built of steel girders. As the vessel is equally supported throughout its length, it cannot be bent, and, as the rails resting upon an immovable road-bed constitute a continuous girder, the carriage is made with its greatest strength in its cross-girders, the longitudinal girders being only of sufficient strength to carry the trucks which are placed under them. The cross-girders are spaced about 7 feet apart, exactly as the rams in the pontoon are spaced. They are supplied with a system of supports, or keel and bilge-blocks, for the vessel. The keel-block running the whole length of the vessel is continuous, and is sufficiently elastic to conform to any irregularities in the line of the keel. The supports under the keel-block, and the other supports of the vessel, are made of heavy steel rods in which a thread is cut for an adjusting-nut, which can be run up or down on the rods. The upper end of these rods, under the bottom and bilges of the vessel, is supplied with an adjustable hinged batten (see Plate IV., Fig. 4, *top*) on a universal joint. These battens have an area of about 9 square feet each, and are cushioned with rubber or other material, to prevent injury to the vessel when it rests upon these supports. The screw and batten may be said to resemble in general shape a huge music-stand.

"The process of lifting a vessel is as follows: The carriage is run from the railway upon the pontoon and secured in exact position on it by means of locks. This insures each screw being exactly above a hydraulic ram. The water is let into the pontoon by sluice-gates, and it goes down, with the carriage upon it, until it rests upon the foundation of the dock, or to a sufficient depth in the water to allow the vessel to be floated in over it without striking the battens of the carriage, which are previously let down by means of the adjusting-nuts until the heads of the screws rest upon the girders of the carriage. The vessel is then brought in over the pontoon and

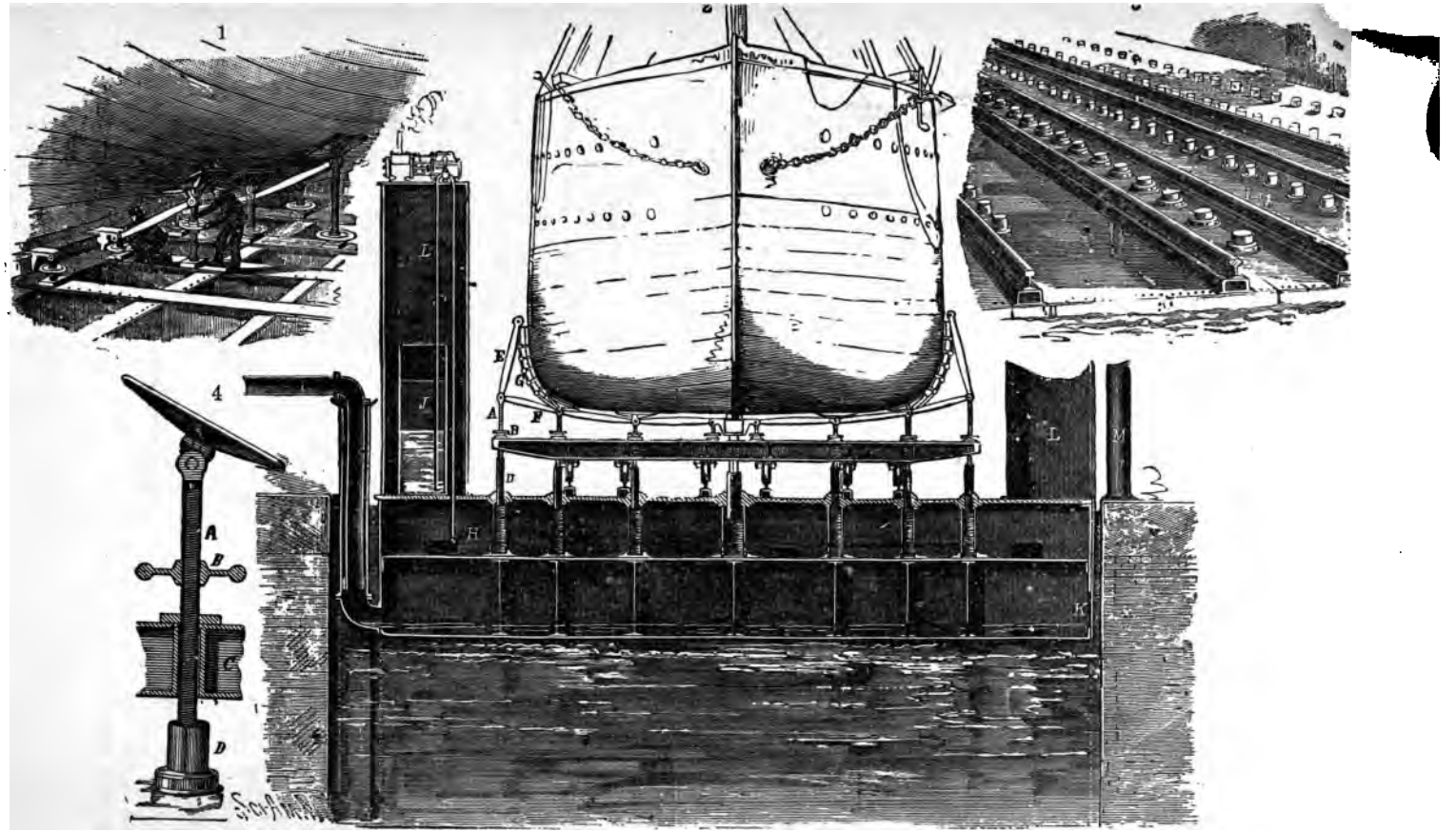


Plate IV.—DETAILS OF THE LIFTING DOCK.

Fig. 1 shows the process of running down the adjusting nut of the supports

Fig. 2, Cross-section of the pontoon, towers and carriage. A, is a side sup-

Fig. 3.

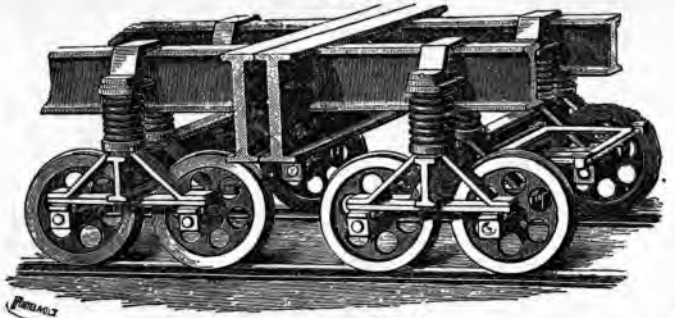


Fig. 2.

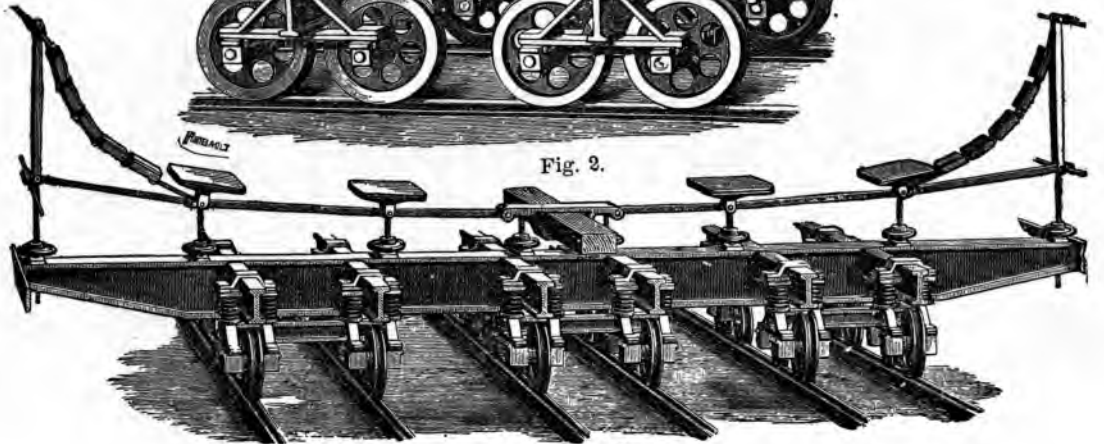
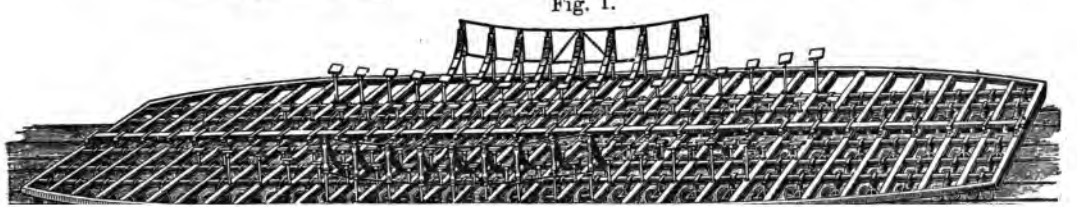


Fig. 1.



located as near as possible with its centre of gravity over the centre of gravity of the pontoon. Adjustable guides from the side of the dock, working by hydraulic power, quickly and gently bring the vessel so that its keel is directly over the keel-block of the carriage. The pontoon-pumps are now set at work, and the pontoon, with the carriage upon it, comes up under the vessel. Just before the keel-block and battens come into contact with it the hydraulic pumps on the towers of the pontoon, which actuate the rams, are set at work, and they gently force up under the keel, the bottom, bilges and sides of the vessel the whole system of supports. The valves are then closed, to prevent the water-pressure from escaping from under the rams, and the pontoon-pump continues to lift the pontoon, with the vessel on it, up out of the water. As the vessel rises, resting upon the system of rams, its weight upon them becomes every moment greater and greater, some of them being slightly depressed and some slightly elevated, and the equalization through the system goes on as the vessel rises, until, when it is entirely out of the water, its whole weight is equally distributed from stem to stern. While it is still resting upon the screws, which have been pushed up and are held by the rams, the adjusting-nuts are run down on the thread of each screw until they have a firm bearing upon the plates of the cross-girders. When this adjustment has been made—which would require only a few minutes for ten expert men to accomplish—the valves are opened, the water-pressure escapes from the rams, and they recede downward into the pontoon. The weight of the vessel has now been transferred from the rams to the carriage, and the equalization of the weight upon the carriage is as perfect as it was upon the rams themselves. As the girders of the carriage are spaced the same as the transverse lines of rams, if we arrange the same number of wheels with each girder, we will then have the same weight imposed upon every wheel, which is intended to be not over eight and one-half or nine tons, which they will be able to sustain, for each wheel will be tested to twenty tons when it is manufactured. As it is a common practice for the railways of this country, and especially so for those of England, to impose a greater weight upon the driving-wheels of locomotives, it will be seen that this is an admissible load for the wheels, which will be arranged in a very simple form of trucks without bogies. As it is necessary for the carriage to move on practically straight lines, the wheels can be arranged with two flanges instead of with one, as a precaution against de-railment, although the breaking of one wheel or of several wheels will not affect the integrity of the carriage. Over each axle is a powerful spring, (see Fig 3, Plate V.) which will also be tested to twenty tons before closing. It has a vertical movement of six inches. When the maximum load—a 5000-ton weight—is placed upon the carriage, these springs will be closed to within three inches. This gives an elastic bearing for the vessel and the carriage, and will serve two purposes—one, to take up any slight irregularities there may be in the track ; the other, to prevent any possible jar to the carriage or to the vessel. When the load has been thus equalized upon the

carriage, it is evident that there will be no more weight brought upon the rails at any point than there is brought upon them by a locomotive on an ordinary railway; so that, so far as the strain upon the rails is concerned, a rail of ordinary dimensions would answer the purpose. But, to avoid the possibility of undue strain, the rails will weigh from 100 to 120 pounds per lineal yard, which is about twice the weight of an ordinary railroad rail. These rails will be of steel, and will rest upon long steel ties which extend under the whole six rails of the railway. They will have a large bearing-surface, will be securely fastened to the rails, and will rest upon the best quality of ballast or concrete. The road-bed itself will be constructed of the very best materials obtainable, and in the most thorough manner. The road-bed will be from forty-five to fifty feet wide.

"The motive-power for hauling the loads will be furnished by powerful locomotives, which will have imposed upon the driving-wheels of each at least 100 tons, to give great traction-power. As the maximum load, including the carriage, will be only 5,650 tons, it will not be difficult to haul it over the grades of the railway. The ordinary consolidated engines of the day will pull from 1,500 to 2,000 tons without difficulty over grades up to twenty feet to the mile. Three such ordinary engines would therefore haul the maximum load; but, with locomotives of double the power of these engines, no difficulty is apprehended in performing the work required, and at ten miles per hour.

"A carriage constructed after the manner described must necessarily move on practically straight lines. It will, however, permit the use of a curve of twenty miles' radius, which is practically a straight line. At points on the line where such a curve as this would necessitate very heavy construction-work in the shape of mountain-cuttings or very high embankments, a change of direction will be obtained by means of turn-tables. (See Plate VI.) These turn-tables are very simple and economical in construction, maintenance and operation. By their use a large amount of money will be saved in construction. The location of the railway, which has been made with great care by instrumental surveys and detailed examinations of the country, is, through the rougher portion of the isthmus, along a succession of valleys between high hills and mountains. In order to pass from one valley to another and take advantage of the natural lines of the country, these turn-tables are employed. Five of them only are necessary. They are built as follows: A segmental basin of masonry is arranged to receive a pontoon and a certain quantity of water. This pontoon is so centered in this basin that it will revolve around a central pivot, although it does not rest upon it. When not revolving, the pontoon rests upon concentric bearing-surfaces in the bottom of the basin. In order to turn a vessel, it is run on to this pontoon, into which the water of the basin has been admitted; the water is then pumped out from the pontoon into the basin again by means of a powerful centrifugal pump until the pontoon floats sufficiently to be lifted from its bearing surfaces. (See Plate VII., Figs. 1 and 2.) It is then, by means of stationary engines

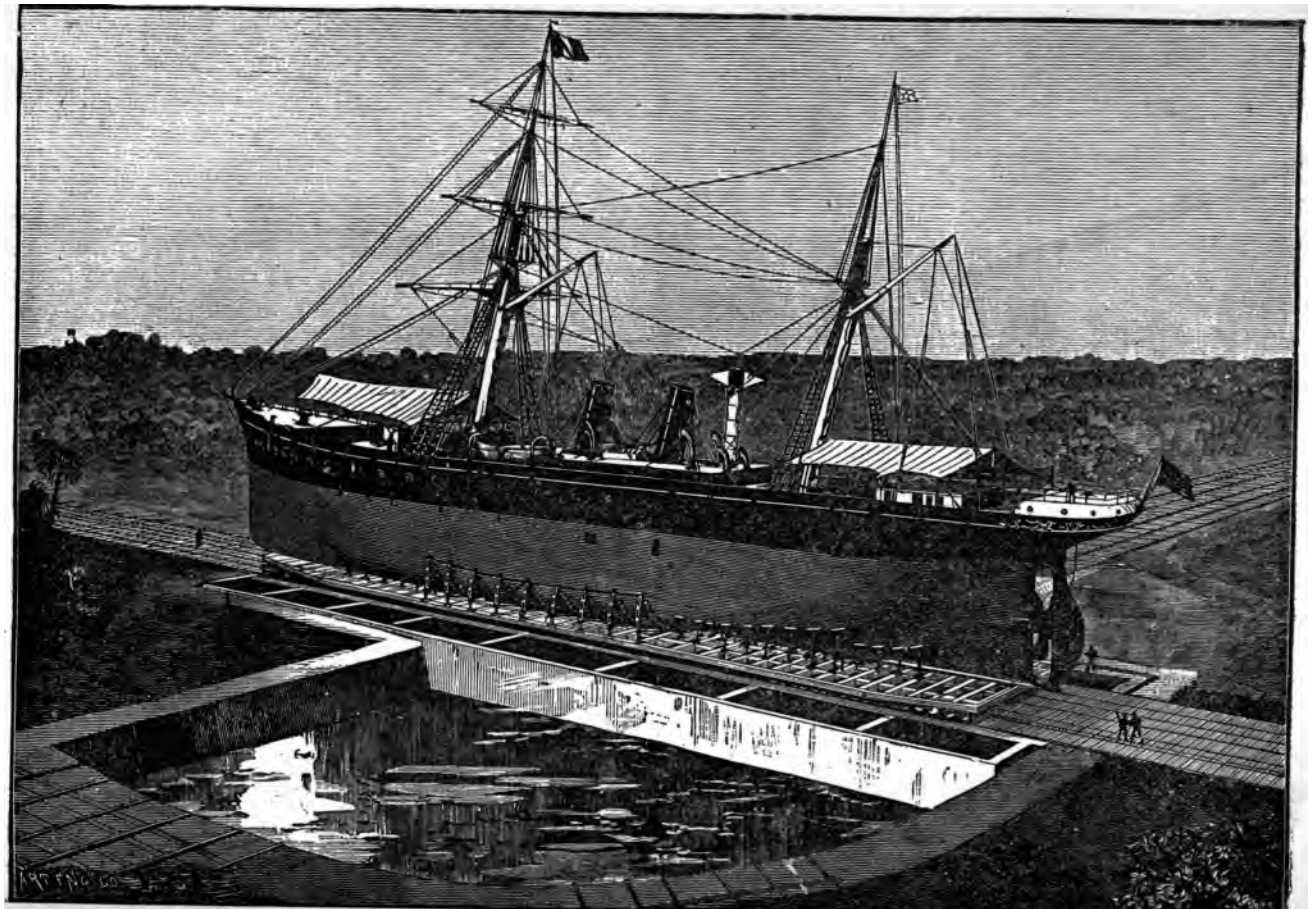


***Plate VI.*—PERSPECTIVE VIEW OF THE FLOATING-TURNTABLE.**

Fig. 1.

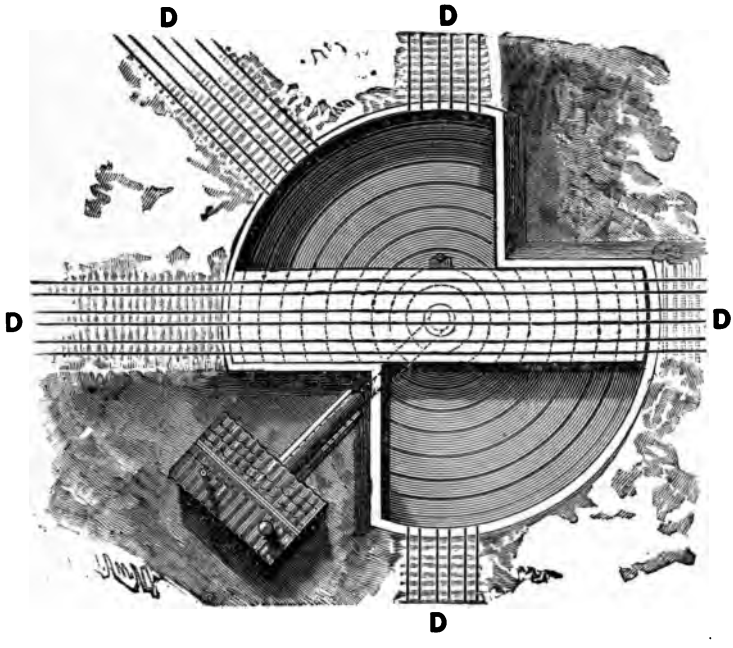


Fig. 2.

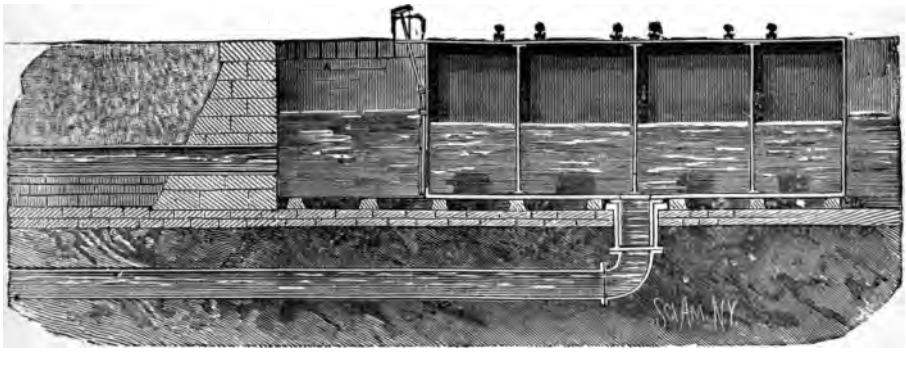


Plate VII.—DETAILS OF THE FLOATING TURNTABLE.

worked by a cable or other means, turned about the central pivot, while floating in the water, until the rails of the deck of the pontoon correspond in line with those of the railway in the new direction. The water is then admitted to the pontoon by means of sluice-gates or valves, and it is again grounded upon the concentric bearings in the bottom of the basin. The vessel is then run off the pontoon upon the railway until it arrives at the next point where a change of direction by this means is to be made, when the same operation again turns the vessel in another direction. At three of the five turn-tables, examinations show that water under a head from the mountain-streams can be utilized to perform the work without the use of the pumps. These turn-tables, while they are a necessity, will also be employed for two very important purposes—one, as passing-places for vessels going in opposite directions. A vessel moving from the Gulf of Mexico toward the Pacific meets at one of these turn-tables another coming from the Pacific, and is on its arrival run across the turn-table on to an extension of the track. The turn-table is then revolved to take on the vessel coming from the opposite direction, which then goes on its way. The first vessel is then run back upon the pontoon and sent on its course, the whole movement occupying but a few minutes. It will be seen that, the weight of the vessel having been equalized upon the carriage by the hydraulic rams, if the centre of the carrriage is brought over the centre of the pontoon, the latter will be balanced when it rises from the bearing-surfaces in the bottom of the basin ; but if the pontoon is not exactly balanced, it can be brought level by letting water into one or more of the compartments on one or the other end of the pontoon. The second purpose that the turn-tables will subserve will be as dry-docks where vessels can be run out on tracks radiating from the segmental basin, on which they can be cleaned, painted or repaired, as the case may be, and where they can remain as long as necessary. (See Plate VII., Fig. 1, D.) As every iron ship must be taken out of the water twice every year, the expense of docking—which is considerable for a large vessel—will be saved. There will be one of these turn-tables at each terminus of the road, near the dock, to facilitate the handling of the business at those points, and they will be located also at other points on the line where the operation of the road may show meeting-points for vessels to be required.

"The changes in grade on the railway will be made by very flat vertical curves. The elasticity of the vessel isself and the movement of the springs will allow a change practically of about two inches in 400 feet. A curve established on this basis has been applied to the working profiles of the railway and found to be perfectly practicable in construction."

* * * * * * * *

"In the discussion of the mechanical appliances, it is only necessary to refer to the very thorough and substantial manner in which a sea-going vessel must necessarily be constructed to withstand successfully the various strains to which it is subjected on the ocean. The flexures in both directions, the torsional strains, and a

combination of these different strains which every vessel undergoes in a seaway, make it absolutely necessary that the vessels should be built with a large factor of safety. Then, again, their decks and beams and plates and ribs stiffen the whole structure for passing through those shocks and impacts which they receive on a voyage, without injury to their structural integrity. The greatest strain which a vessel could possibly undergo when lifted and transported in the manner we have described bears no comparison to those which the same vessel must undergo in its natural element. It will be seen, also, that by the very large number of broad-surfaced supports on which the vessel is carried she cannot be strained in any part of her bottom or bilges or sides, and even one that is old and tender can sustain no injury in transportation. A large number of experts in designing, building and handling vessels of all kinds and sizes could be quoted to show that in their minds there exists no practical objection to the plans as herein described." (See Report of Senate Committee, pp. 70 to 80.) "Obstacles, one after another, have been overcome, by study and by using principles and appliances, with perhaps new adaptations, that are already in use in the world for the same purposes, though perhaps on a smaller scale."

In this age such wonderful progress has been made in mechanical appliances that any proposed work required for the good of mankind seems to be in the power of man to accomplish. In railway advance, especially, the development in power, speed, economy and adaptability to the wants of man, is marvelous. In a recent address before the British Association, by Mr. B. Baker of England, we find the following statement:

"Fifty years ago the chairman of the Stockton and Darlington "Railway, when asked by a Parliamentary committee if he thought "any further improvements would be possible on railways, replied "that he understood in future all new railways would have a high "earthwork bank on each side to prevent engines toppling over the "embankments and to arrest hot ashes which continually set fire to "neighboring stacks, but in other respects he appeared to think per-"fection was attained. Shortly before the introduction of loco-"motives, it was also thought perfection was attained when low "trucks were attached to the trains to carry the horses over the por-"tions of the line where descending grades prevailed, and all the "newspapers announced, with a great flourish of trumpets, that a "year's experience showed the saving in horse flesh to be fully 33 "per cent."

In remarkable contrast with this is the record of a train recently hauled over the New York, West Shore and Buffalo Railway. This train ran several miles at the rate of forty-three seconds per mile, 84 miles per hour. The weight of the train was 155 tons, and the average running speed for the whole distance—426 miles—was 57 miles an hour.

It is interesting to note the remarkable advance also in locomotive construction during the last fifty years. The first engine built

by the Baldwin Locomotive Works in 1832, named "Old Ironsides," weighed something over *five* tons; the cylinders were 9½ imches in diameter by 18 inches stroke; the wheels were made with heavy cast iron hubs, wooden spokes and rims and wrought iron tires; the frame was of wood placed outside the wheels, and the boiler was 30 inches in diameter. The *Philadelphia Chronicle* of November 24, 1832, noticing a trial of this engine, stated:

"This engine will draw **30** tons gross on a level road."

The locomotive was set at work on the railroad, and the following appeared in the newspapers:

"Notice. The locomotive engine (built by M. W. Baldwin of this "city) will depart daily *when the weather is fair*, with a train of pas- "senger cars. *On rainy days horses will be attached.*"

In remarkable contrast with their first locomotive built 53 years ago is the immense "Decapod," or ten-wheeled coupled consolidated locomotive, built by the Baldwin Works recently for the Dom Pedro II. Railway in Brazil. Its general dimensions are as follows: Total weight of engine and tender ready for work, **224,000** lbs, equal to **112** net tons; diameter of boiler, **64** inches; heating surface, **1943** square feet; cylinders, 22 inches by 26 inches, and it is guaranteed to haul **3600** gross tons on a level track.

On December 7th, 1885, a freight train over one mile long and weighing 3253½ gross tons was hauled into New Orleans over the Mississippi Valley Railroad, by one engine weighing 55 tons.

We can see from the above with what ease the locomotives of the day, built for *ordinary* railroads, can haul a loaded vessel over the Ship-Railway by attaching as many as may be required to the car according to the size of the vessel.

Advances as remarkable have also been made in the construction of railways, and in the various kinds of rolling stock. In other departments of mechanical science, especially in the employment of hydraulic appliances there has also been a great advance. There is now building in Scotland by Messrs. Sir John Fowler and B. Baker, civil engineers, the greatest bridge in the world. Two of its spans are each one thousand seven hundred and ten feet in length, and the top chord of the bridge is over three hundred and fifty feet above high tide. The superstructure will require forty-six thousand tons of steel, all of which, mostly composed of plates, is being bent into shape by hydraulic presses of various descriptions. In the address of Mr. Baker alluded to, we find the following:—

"Hydraulic appliances are also an indispensable part of the "scheme for erecting the great seventeen hundred foot spans. Massive "girders will be put together at a low level and be hoisted as high as "the top of St. Paul's Cathedral by hydraulic power. Continuous "girders, nearly a third of a mile in length, will be similarly raised. "Not only the girders, but workmen, their sheds, cranes and appli- "ances will be carried up steadily and imperceptibly as the work of

"erection proceeds, on platforms weighing in some instances more "than one thousand tons.

* * * * * * * *

"Not merely in the superstructure, but in the construction of the "foundations, were hydraulic appliances of a novel character indis- "pensable at the Forth bridge. Huge wrought iron caissons, or "cylinders, seventy feet in diameter and seventy-two feet high, were "taken up and set down as readily as a man would handle a bucket. " * * * It would be possible, indeed, with the appliances at "the Forth bridge, to arrange that the simple opening of a valve "should start digging" (by hydraulic power) "at the bottom of the "sea, riveting at a height of nearly four hundred feet above the sea, "and all the multifarious operations of bending, forging, hoisting, and "extending over a site of a mile and half in length."

With this wonderful adaptation of hydraulic power to moving heavy masses before us, who can doubt that it may also be applied to the lifting and handling of heavily-loaded vessels, and in the distribution of their weight, as has been described above.

That the vessels on the docks or on the railway will not be subjected to strains injurious to them, or in fact greater than they undergo in an ordinary voyage, is evident on a little reflection by those who have carefully studied the illustrations and description. It may not be known, even to those who are accustomed to travel on the ocean, that a vessel undergoes strains in her ordinary voyages very severe compared with any she will possibly meet with on the Ship-Railway. The following letter is from a gentleman of high scientific attainments and large practical experience as an engineer, and his observations may be implicitly relied upon:—

The Cornell University,
Department of Civil Engineering,
E. A. Fuertes, Dean.

Ithaca, New York, Nov. 3d, 1884.

DEAR MR. CORTHELL:—Not knowing the address of Captain Eads, I have been unable to send him the following, which was undertaken as an abstract experiment; but *dedicated* to him, when found to bear strong testimony to his foresight.

I was on board the Str. Germanic, a staunch ship of the White Star line, in the Fall of 1881, homeward bound from Liverpool. On the first Sunday after leaving England, the wind was blowing at the rate of sixteen to eighteen miles per hour, rather gustily, with a moderately high sea. It then occurred to me to measure the deflection of the ship, being impressed not only by the effect of the waves upon her length and sides, but also by the strain upon her frames, imposed by the enormous moments of her huge spars. I had with me a reconnoitering field glass (provided with cross hairs, power 30) which I secured to a convenient angle in the wood work; and soon became satisfied that the deflection was large enough to be measured with the means at my command. I then counted 55 steps (each 29") from the telescope to an awning post painted white, and 109.5 steps to a rope in the rigging; and to the rope I tied a piece of white tape in range with the telescope.

I now tied a piece of black string to the white post, in the range of the telescope and the distant white tape in the rigging, adjusting it when I thought there was no deflection. By observing the nature of the waves, this adjust-

ment was found much simpler than I anticipated. I then found the central deflection, by keeping the pointing on the distant tape, and observing the up and down motion of the black string (on the post) across the field, measuring the amplitude of this motion by the position of particles of dust adhering to the cross-hairs of the eye piece (negative). After many trials I measured on the white post, the distance subtended (from the telescope end of the line) by the dust particles above mentioned, and found for the middle "total deflection" nearly 13 inches. Also, it was evident that the flexure was greater when bow and stern were raised, than when the midship section was raised as determined by observing the position of the ship upon the waves she was riding at the time; this shows that the deck was stiffer in extension than in compression.

I must here say, that the measurements were difficult to make, but are substantially correct to establish beyond doubt the large amount of absolute deflection. It is not claimed that they are accurate enough to give with precision the relative deflection. However, the line being nearly two hundred and sixty-four feet long; the white post at its middle point; and supposing the concave and convex flexures to be about alike, the mean deflection was: $\frac{264' \times 12''}{6.5''} = \frac{1}{487}$ of the length.

The weather was only a little rough, and very far from what must be encountered by any sea-going ship; yet I am sure no railroad bridge, short of exposure to a cyclone is ever subjected to the strain suffered by the Germanic on this Sunday, with absolute safety.

Though a short span bridge is thumped considerably by a fast moving train, it cannot be compared to a ship when a sinking or receding sea instantly withdraws the enormous water pressure against her sides, and the reaction of her frame is reinforced with equal suddenness, by the outward pressure of her cargo. Also the sea strikes blows with concentrated force upon restricted areas of the ship's surface, causing the "dreaded tremor" from stem to stern, and teasing her joints and timbers with all kinds of flexures, torsion and impacts. Only those who have personal experience with the sea in a hurricane can realize the stiffness required in a sea-going vessel. It is strange to see how strongly intolerant popular misconceptions get to be in questions of this kind. No one would doubt for a moment that a railroad bridge can be transported safely over any railway by resting its extremeties upon trucks, used as moving abutments; and yet, I know of no railroad bridge of the ordinary types, that would not break to pieces if the abutments used were two floating scows made to stand the surging and blows of a stormy sea, even if the scows were *supposed* to be rigidly connected. While a ship must be trussed so that it may stand safely on end, or shaken violently when held in the middle or by her extremities, the popular prejudice against the ship-railway is based upon the unjustifiable *assumption* that all ships are wanting in the very quality that they must possess, and do possess in the highest degree, viz: Stiffness, compared to which the stiffness of a railroad bridge is as that of a flexible reed.

The deflection of the Germanic surprised me to such an extent, that I went to her engine room to study the expedients adopted to counteract the effect of this deflection upon the moving lines of her engines. I found the engine frames had been devised with an evident previous knowledge of an expected large deflection. I venture to say that the future history of total side support to ships in railway transit will be like that of many previous phantoms; like the dangers of the railroad wheel tire, and the introduction of steam and gas into dwellings. I expect to see the day in which a 5000 tonner will cross the American Isthmus loaded with coal, resting on her keel, with only enough side support to keep her deck level, and especially iron vessels or ships built on purpose for this traffic.

Wishing you God Speed, believe me,

Faithfully your friend,

E. A. FUERTES.

The plans described on the preceding pages are completely illus-

trated in a working model over thirty feet in length. The argument enforced by this model is unanswerable, and it has led many, who at first doubted the practicability of the plans, to express entire confidence in their success. The two letters which follow are characteristic of many that might be offered, and they speak for themselves:

"A. K. Miller & Co., Ship and Steamship Agents,
"37 Carondelet Street, New Orleans, June 18, 1885.

"E. L. CORTHELL, ESQ., 34 Nassau Street, New York.

"DEAR SIR:—I am in receipt of your esteemed letter of the 15th inst., and am much pleased to note you are quite well, and trust your enterprise will meet that support which it so justly deserves.

"In this connection, permit me to make some observations regarding your railway project for the transportation of ships across the Isthmus.

"As a practical seaman and commander of ships for many years, during which time I have had the occasion to raise and repair large ships in different styles of docks, marine railways, etc., I had formed, or rather had come to the conclusion that to raise a loaded ship in the manner proposed by Capt. Eads, and to transport her as suggested, would subject the ship to such strain that it would be simply impracticable, and could not succeed.

"While your ship-railway model was on exhibition at this city, I visited it on several occasions, and after a thorough examination of the manner of raising, application of rams and distribution of lifting power, I have but one opinion regarding the question—which is, that ships of the largest class, loaded with full cargoes can be safely lifted, and transported in the manner proposed without subjecting them to any more strain than they would undergo during a sea passage, and in fact much less fatigue than they would encounter during gales of wind such as ships are at times subjected to in all oceans of the world. I trust you will be enabled to push your work to a speedy and successful issue. Your ship-railway would largely develop trade in this quarter of the globe, and would also increase shipments and traffic from the Pacific coast.

"Very truly yours, A. K. MILLER."

"Washington, June 25, 1885.

"E. L. CORTHELL, ESQ.

"DEAR SIR:—Your letter of the 15th inst. came duly to hand. Sickness and excess of business must be my excuse for delay in answering.

"In reply to your questions, I would state that I was manager and Superintendent of the Marine Railway at Nassau, N. P., Bahamas, for ten years, and during that time—as near as I can remember—I hauled out and repaired between 800 and 900 vessels, about one-third of which were steamers, and perhaps one-fifth of them loaded.

"As we charged so much per ton for cargo on board, as far as practicable the vessels were discharged before being taken out.

"My experience was that it was easier and safer to take out a loaded vessel than one in ballast. The railway was about 800 feet long, and similar in all respects to your model, the principle being the same. There was not one dollar's damage done to any vessel in hauling out while I had charge of the railway.

"This, I believe, answers all your questions.

"Yours respectfully, EPES SARGENT,
"338 Penna. Avenue."

The address delivered by the author, August 26, 1885, before the American Association for the Advancement of Science, on "The Interoceanic Problem and its Scientific Solution" has brought many letters from various parts of the world confirming its statements. The following is characteristic of these letters; it is from a gentle-

man who is considered as an authority in mechanical engineering, and is a prominent writer on subjects kindred to the ship-railway, having been selected to write several important articles in Spon's Dictionary of Engineering, on Mechanical Engineering subjects

[TRANSLATION.]

"Lausanne, Oct. 6, 1885.

"MR. E. L. CORTHELL, Civil Engineer, New York.

"SIR:—I have to thank you for the honor you have done me by sending me a copy of your address before the American Association for the Advancement of Science on 'The Interoceanic Problem and its Scientific Solution.'

"I see with great interest that you and Mr. Eads meet with approval and support in the bold project of an interoceanic passage of which you are the promoters.

"The science you have displayed, the correctness of your principles and the breadth of your views lead me to hope that you will be enabled to accomplish this great work.

"As you have said, it is necessary only to develop and perfect by all the mechanical resources which the science of the present day possesses—what has already been done under other forms on a smaller scale.

"This will not be the first time that your country has shown to the world what grand enterprises can be accomplished by a young and enterprising nation full of life and faith. Accept, sir, the expression of my high consideration. J. GAUDARD."

As to the comparative cost of transportation by ship canal and ship-railway, the proofs can be easily adduced that the latter is the least expensive. In discussing this subject of economy of the ship-railway, we will divide it into two parts, the *theoretical* and the *practical*. The following is abstracted from the paper on "Canals and Railroads, Ship Canals and Ship-Railways," presented by the author to the Annual Convention of the American Society of Civil Engineers, June 25, 1885:

"The boat or steamer in its passage through the water in a re-
"stricted channel creates a hill up which it is constantly climbing.
"The more rapid the speed the steeper the hill. Thus the boat is
"absolutely compelled to move at a very slow speed; in fact, it
"would be almost impossible to attain in a narrow and shallow canal
"its normal ocean speed."

Proof of the above is found in the well known valuable work on Naval Architecture by J. Scott Russell, and the following extracts are from chapters 31 and 32 of that work:

"The water excavated from the way of the ship causes a con-
"tinual accumulation of water in the region of the canal, *towards*
"which the ship is moving. * * * *

"If the wave travel ahead of the ship, only one-fourth of the space
"of the ship, the accumulation will be quadrupled; one-eighth will
"make it eight-fold and so on, until the progress of the ship becomes
"extremely difficult, or impossible.

"This is what constantly takes place, as the rise of the ship and
"the pace in a narrow and shallow canal become greater. Practical

"working at high speed becomes, not difficult or costly, but impracticable. * * * *

"The consequences of this rapid increase of head accumulation, "which takes place as the speed of the wave in advance of the vessel diminishes, are very serious. *First*, it throws the ship's head "up out of trim; *next*, it increases the pressure of water on her bow; "*third*, it makes her travel up-hill; *fourth*, it produces a backward "current along her sides. And these hindrances to speed accumulate rapidly—much more rapidly than as the square of the resistance, until the amount may become insuperable; that is, many "times the resistance due to the law of the square of the speed.

* * * *

"It is now necessary to notice the complimentary effect to that of "accumulation in advance of the vessel; it is subsidence of water "astern. It being known that the excavated water is sent on in advance of the vessel, it becomes plain that the channel out of which "this water has been taken must have its height lowered by the subsidence of the water into the vacant canal out of which the ship "has been drawn. * * * *

"Not only is the section of water-way affected by head accumulation, but the skin of the ship is affected by it, as the additional "head and hollow give rise to an increased speed of water, running "from stem to stern, causing additional friction. * * *

"It must not be forgotten, that these last conditions do not "affect sea-going ships in their ordinary duty. But in the navigation "of shallow waters, rivers like those of India, ship canals and all "sorts of inland navigation, they are all important."

In reference to the *practical* part of this subject, the records of canals and railways are full of evidence to show that the theoretical reasons above given have been at work during the last fifty years reducing the cost of transportation on railways and preventing any reduction on barge and ship canals. In a report before a select committee of the House of Commons on canals, Mr. James Allport, who was for many years manager of the Midland Railway Company, testified particularly in regard to the transportation of coal. He stated: "In thirty years the railway-borne coal into London has increased from 377,000 tons in 1852 to 6,546,000 in 1882." Also, that the amount of sea-borne coal to London remained nearly stationary during that time and that "during the whole of the years of canal-borne coal into London, although the canals had independent routes "not under the control of railways, the total of the canal-borne coal "was 7,964 tons against railway-borne coals 6,750,000." The following is his opinion in general: "I am quite sure of this, "and I say this after upwards of forty years' experience as a railway "manager, that the canals cannot compete with the railways, "whatever they do."

Canal construction has been nearly discontinued in England, and he states as a fact as follows:

"I do not remember a single canal being constructed during the

"whole of my railway career, unless it be some short branch of a few "miles in length."

From carefully prepared tables of canal and railway transportation, we find that in every instance on canals, and even rivers, in England and France, the cost of "conducting transportation" is greater than it is on many first-class railroads.

In reference to canals in the United States, the latest report of the Census Bureau, based on the census of 1880, "Vol. IV, Transportation," is very suggestive. The following extracts are taken from it: Page 729, "sketches of the abandoned canals of the country are given, together with a supplemental table which, in a measure, shows the influence of railroad competition upon these great works of the past generation. * * * Adding together the totals of the operating and abandoned canals, as shown in tables one and two, we have a grand total of 4,468.60 miles of canal. * * * Of these 1,953.56 miles are now abandoned and a large portion of the remaining 2,515.04 miles is not paying expenses. This is largely due to railroad competition. * * * In New York State, 356.66 miles of lateral canals, costing $10,235,314 have been abandoned. In Pennsylvania 447 miles are abandoned, costing $12,745,780. In Ohio, 205 miles, costing $3,000,000 have been abandoned. Indiana with the aid of her creditors, constructed 379 miles of canal in 1851, costing $6,325,262, all of which were abandoned upon the construction of railroads along the lines of the canals. The most enterprising and sagacious men in the country were engaged in projecting and building these canals, but their expectations with regard to them were never realized."

The Ohio Canal, running the whole length of that State, is shortly to be abandoned, on the recommendation of the Engineer of the Board of Public Works; it not being self-sustaining.

The average ratio of expenses to the gross receipts on all the canals operated by the State and corporations in the United States is sixy-five per cent., which is greater than that of first-class railways.

The following extracts in reference to the cost of transportation by canal and railway in this country are from two prominent and experienced railroad managers:

"If the tonnage which passed through this canal" (Erie) "was "delivered for transportation to the West Shore Railway," (New York, West Shore and Buffalo) "it could be hauled and delivered "more cheaply than by the water route, and in less than one-quarter "of the time now required."

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"The contest between the canal and the rail has always interested "me. Ten years since I became satisfied that the abandonment of "medium-sized canals, such as the Erie, the Delaware and Hudson "and Delaware and Raritan, would simply be a matter of time. " * * In regard to the Erie, two classes of expenses are "rarely noted when a camparison is made with the rail; one being

"the maintenance of way, which the State pays for, or rather the "increased taxes of the people; the other a depreciation and renewal "of equipment, which the boatman does not count, as for some years "there have been no renewals and but slight repairs. The only "expense returned is that incurred in actually running the boats, "equivalent to the railroad charge of 'conducting transportation'. "Now, making the necessary allowance, the West Shore can transport "at least thirty per cent. cheaper than the canal."

If we take up the subject of *ship* canals, we find the same resistances to overcome, and a great increase of expense with the increase of speed. In Volume 66, page 162, Proceedings, Institution Civil Engineers, Great Britain, the following statement is made:

"The Warrior" steamed through the Suez Canal in 1870 in twelve hours fifty minutes, or at the rate of 6.85 knots per hour. She was 380 feet long and her midship section was 1,219 feet, with an indicated horse power of 5,469, and with a speed upon the sea of 14½ knots per hour. The *retarding current* which the Warrior was obliged to overcome was nearly 11 feet per second."

On page 261, the statement is made by Captain John Steele from his own experience, that with a ship drawing 20 feet, a speed of more than 4 knots an hour would result in mishaps. The speed through the canal is restricted by rules to five knots an hour. In a paper recently read before the Austrian Society of Engineers, on the Suez Canal and its intended improvements, it is stated:

"The long time occupied in passing the canal is a serious objection. "The maximum speed allowed is five knots per hour. This, and "the time lost in turn-outs, makes the trip a long one; and greater "speed, which would be better for steering the vessel, is prohibited "on account of the dangerous wave action on the shores. Notwith-"standing these precautions, these slopes are damaged continually, "although a considerable length of the slopes has been protected by "rip-rap. The area of the cross-section of the canal is 3,956 square "feet. This is too small for vessels with a displacement of 645 "square feet, and is the reason for running many vessels ashore. "(From 1870 to 1883, eleven per cent. of all vessels went into the "shore.) These stranded vessels are pulled off by three powerful "steam tugs, at the expense of the Canal Company; this work "usually consumes five hours."

On the Welland Ship Canal in Canada, the average speed is one mile per hour, and it is the same on the North Holland Ship Canal from the Helder to Amsterdam.* The estimated time of passage through the projected Huron and Ontario Ship Canal, 100 miles long, was *four days*.†

Numerous experiments on railroads, on the ocean, and on barge and

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* See Internal Commerce United States, 1885, page 494.

† See Report New York Produce Exchange, 1872-1873, page 66.

ship canals, show that generally the increase of resistance to railway trains is very small with the increase of speed ; to vessels on the ocean as the *square of the velocity*, and in the restricted channels of barge and ship canals, as the *cubes of the velocity ;* e. g. If the resistance is ten pounds per ton at two miles per hour on a railroad, it would be nearly the same at four miles per hour on the railroad ; on the ocean forty pounds, and eighty pounds on the barge or ship canal.

Having stated the theoretical and practical proofs in regard to the cost of transportation on railroads and canals, let us extend the development of the railroad to the greater work of transportation by ship-railway, and we will find proofs of the statement that a still greater decrease in cost of moving goods will result.

Ordinary sea-going steamers transport freights at a cost of about 0.5 mill per ton per mile, running expenses alone considered, and not including interest, insurance, depreciation of steamer, and profit, or 0.3 mill by the best examples of sea-going steamers. The cost on a ship canal at two miles per hour (assumed as the economical speed), as against twelve miles per hour on the ocean, and with the same power required, would increase the cost six times, or to 3.0 mills per ton mile. The cost of hauling on a railroad on the same basis would be about 0.6 mill—one fifth as much only. It may be stated broadly that railroad transportation in this country has been so far reduced in cost as to make it possible to haul freight at about four mills per ton per mile including *all* expenses, even the terminal and other handlings of *local* as well as through freights, also expenses of repairs and renewals, general expenses of management, and the many other charges that go to make up the details of the cost of transportation. The cost of *handling* freight is not perhaps appreciated by even railroad managers, for, while immense and continual reductions are being made in the cost of *hauling*, but little advance has been made in reducing the cost at terminals and stations. It costs as much to *handle* a ton of goods at the New York terminals as it does to *haul* it to Albany or Philadelphia. Another important item in the cost of ordinary railroad transportation is the labor. An army of employees is required for all the various duties devolving upon railroads ; hundreds of returns and reports require a large clerical force. The relations and connections with other roads in cars, goods, back charges, &c., make a large amount of work necessary. The assorting of goods for different destinations, the handling of cars on sidings, and in terminal and division yards require not only a variety of labor, but expensive power also.

The expense of doing all this work is however so systematically performed and recorded, on the best railroads of the country, that the cost of the various items is fully known. We need not have further to do with it here, but enter at once upon the Ship-Railway method, and its great advantages over the ordinary railroad.

The estimated cost of operating the Ship-Railway is as follows at the Isthmus of Tehuantepec:

First. The maintenance of the permanent way. The cost of maintenance in this country on a first class double track railroad, including sidings, yards, buildings, &c., in other words, everything but rolling stock, is about $1700 per mile of railroad, sidings being at least 25 per cent. of the whole. The wear on the rails and ties, switches and frogs, is constant and expensive. On the ship-railway, the speed being slower, the line straight, the rails heavier, and the whole superstructure more nearly perfect, there will be much less wear and none of the expense arising in this country from frost and snow. There is, however, a greater rainfall, probably more deterioration of materials in wooden structures, and an increased cost of labor; also, 50 per cent. more track to be kept up. It will be fair to estimate the maintenance at $2500 per mile, or a total for the whole distance (134 miles) of	$335,000
Second. The cost of operating the terminals, from a careful detailed estimate of cost of labor, coal, materials and repairs, will be $350 per day, or for 365 days, $127,750; and for two terminals, per annum, ...	255,500
Third. The cost of operating the five ship-railway turn-tables, at $300 per day	109,500
Fourth. The motive power for hauling vessels, per annum, 4,000,000 tons at 0.52 mill per ton per mile, ...	278,720
Fifth. Telegraph expenses, ...	20,000
Sixth. Incidentals, ...	40,000
Seventh. General expenses, ...	50,000
Total, ...	$1,088,720

Add for other expenses and contingencies, 10 per cent.; the total then reaching $1,197,592, or in round numbers, $1,200,000, or 30 cents per ton on 4,000,000 tons.

The cost of operating the Ship-Railway, may be ascertained by another method, as follows:

The cost per ton per mile on the best railroads, is not over 3 mills per ton per mile for *through* freight. From this should first be deducted the cost of such work as does not pertain to the Ship-Railway. All such items of cost appear on page 81, Penna. Railroad Report of 1885.

Deducting irrelevant items we can properly reduce the cost 48 per cent., or to 1.56 mills; but a still further reduction is proper. Much larger loads are carried, the ratio of paying to non-paying loads is greater, the frictional resistance per ton to the motive power is reduced at least 30 per cent., the rails are straight, the track perfect, the grades light, and greater results are obtained with less fuel and service.

The history of railway transportation has conclusively shown,

that "the cost of railway transport *diminishes* as the *Unit of dispatch is increased.*"

The average paying load on the New York Central Railroad in 1883, was 199 tons, the average non-paying load, 350 tons, total 549 tons. The average load on the Ship-Railway may be assumed at 1,800 tons paying load, or 3,000 tons total load; or about *nine* times as much paying load as on the railroads. The above favorable conditions allow us to reduce the cost to *1 mill per ton per mile.*

Fifty per cent of the cost of operating is labor, which should be doubled for a tropical country, increasing the cost to 1.5 mills, or for 134 miles, 20.1 cents, which it should be remembered is the *total* cost, not simply the cost of *carriage.*

The cost at the terminals will be as follows:

If ten ships are handled daily, of 1,500 tons each, the labor at the dock will be per day,		$174.00
The coal, stores, wear and tear of machinery,		150.00
Total,		$324.00
To cover contingencies, say,	$350.00	
Or, per ship,	35.00	
Or, per ton,	2⅓c.	
Or, for two terminals,	4⅔c.	

The cost of operating the five turn-tables in making changes of direction (which, however, will not be more than the cost of operating the sidings on railroads) will be *two* cents per ton for all.

The total cost per ton will therefore be, 20.1 cents plus 4.66 cents, plus 2 cents, equal to 26.76 cents. Adding, however, 15 per cent. to cover any unexpected expenses, we have a total cost of about *30* cents per ton.

This estimate, though made on an entirely different basis, agrees with our previous statement.

In comparing the Tehuantepec Ship-Railway with the Ship Canal, the cost of construction will be $75,000,000 for the Ship-Railway, and probably $400,000,000 for the Panama Canal, and $200,000,000 for the Nicaragua Canal (Major McFarland's estimate for the latter was $140,000,000 with labor at $*1.00* per day, while the average cost on the Panama Canal is $*2.00.*) The cost of maintenance will also be much less.

The road-bed of the Railway is above the water, and is nowhere subject to the dangerous floods or engulfing slides from immense cuts. The road-bed is 50 feet in width, whereas the prism of the canal must be at least 200 feet wide, from which all washed-in material must be removed by very expensive means.

The Suez Canal, where the rain-fall is about *2* inches per annum, required in 1883, in the canal proper, the dredging of 781,282 cubic yards. The cost for cleaning the canal was about 2,000,000 francs ($400,000). The total expenses for maintenance and working the canal, were $*2,784,869.* The material in this canal can be cheaply

thrown out on either side by the dredges, and only 40 per cent. of the distance is through cuts over 10 feet high above the water line.

The expense at Panama will be largely in excess of that at Suez, as the prism of the canal will be exposed to a rain-fall of about 120 inches per annum, falling on enormous clay slopes, one of them over 400 feet in height.

At Nicaragua the length is 181½ miles, about 30 miles only of which is open water of full depth. The remainder is a dredged, excavated, embanked, or walled channel, with several locks to be maintained. The cost of towing sailing vessels through either canal will be considerably more expensive than hauling them on the Ship-Railway; and the cost of propelling a steamer by her own power will be, as has been previously shown, 3.0 mills per ton per mile, as against say 0.5 mill per ton per mile transported by the Ship-Railway.

The history of transportation in the last half century proves conclusively the vast superiority of the railway over the canal in speed, economy and convenience.

The inevitable development of the railway in the next half century will be as marvelous as in the past. These results will be obtained by improvements in the road-bed and its superstructure, in alignment, in the increase of load and power of the motors that haul it, and in lessening the expense of handling goods at stations and terminals.

All these advantages the ship-railway method possesses in a greater degree than an ordinary railway could ever expect to have.

The same causes that have dried up the beds of the ordinary canals, whenever railroads have come into competition with them, will produce similar results wherever ship-railways shall compete with ship canals.

George Stephenson set in motion forces that have already proven more beneficent factors in the world than his wildest fancies ever pictured; but those forces will yet produce results that will far outreach all that has been hitherto accomplished. We are but entering upon the era of cheap and rapid transportation. The principles that have proven most potent in the past, in developing the ordinary railway, and in reducing the cost of transportation, will be most efficiently applied in the ship-railway.

CHAPTER VI.

DISTANCES SAVED—TONNAGE EXPECTED—GOVERNMENT STATUS OF THE ENTERPRISE—BENEFITS TO THE UNITED STATES AND MEXICO DURING CONSTRUCTION—GENERAL RESULTS.

The following distance tables were computed by the United States Coast Survey, and show the great advantage of the Tehuantepec route over present routes:

TABLE OF COMPARATIVE DISTANCES IN STATUTE MILES.

	Total Distance.	Excess over Tehuantepec Route.
FROM NEW YORK TO HONG KONG.		
Via Cape Horn	20,379 miles.	8,777 miles.
Cape of Good Hope	16,945 "	5,343 "
Suez Canal	13,596 "	1,994 "
Panama R. R.	12,953 "	1,351 "
Isthmus of Tehuantepec	11,602 "	....
NEW YORK TO YOKOHAMA.		
Via Cape Horn	19,802 "	9,796 "
Cape of Good Hope	18,085 "	8,079 "
Suez Canal	15,527 "	5,521 "
Panama R. R.	11,256 "	1,250 "
Isthmus of Tehuantepec	10,006 "	....
NEW YORK TO AUCKLAND, N. Z.		
Via Suez Canal	16,871 "	7,447 "
Cape of Good Hope	16,719 "	7,295 "
Cape Horn	13,890 "	4,466 "
Panama R. R.	10,305 "	881 "
Isthmus of Tehuantepec	9,424 "	.... "
NEW YORK TO MELBOURNE.		
Via Cape Horn	15,215 "	4,150 "
Suez Canal	15,171 "	4,106 "
Cape of Good Hope	15,019 "	3,954 "
Panama R. R.	11,826 "	761 "
Isthmus of Tehuantepec	11,065 "	.... "
NEW YORK TO HONOLULU.		
Via Cape Horn	15,826 "	9,163 "
Panama R. R.	7,939 "	1,276 "
Isthmus of Tehuantepec	6,663 "	.... "
NEW YORK TO SAN FRANCISCO.		
Via Cape Horn	15,687 "	10,797 "
Panama R. R.	6,063 "	1,173 "
Isthmus of Tehuantepec	4,890 "	.... "
LIVERPOOL TO HONG KONG.		
Via Cape Horn	20,606 "	5,353 "
Panama R. R.	16,471 "	1,218 "
Cape of Good Hope	15,722 "	468 "
Isthmus of Tehuantepec	15,253 "	.... "

TABLE OF COMPARATIVE DISTANCES IN STATUTE MILES.

	Total Distance.	Excess over Tehuantepec Route.
LIVERPOOL TO YOKOHAMA.		
Via Cape Horn	19,400 miles.	5,945 miles.
Cape of Good Hope	17,653 "	4,198 "
Panama R. R.	14,540 "	1,085 "
Isthmus of Tehuantepec	13,455 "	.... "
LIVERPOOL TO AUCKLAND, N. Z.		
Via Cape of Good Hope	16,221 "	3,412 "
Suez Canal	14,645 "	1,836 "
Cape Horn	13,897 "	1,088 "
Panama R. R.	13,312 "	503 "
Isthmus of Tehuantepec	12,809 "	.... "
LIVERPOOL TO SAN FRANCISCO.		
Via Cape Horn	16,552 "	8,250 "
Panama R. R.	8,885 "	609 "
Isthmus of Tehuantepec	8,276 "	.... "
NEW ORLEANS TO HONG KONG.		
Via Cape Horn	20,804 "	10,531 "
Cape of Good Hope	17,485 "	7,212 "
Suez Canal	15,108 "	4,835 "
Panama R. R.	12,308 "	2,035 "
Isthmus of Tehuantepec.	10,273 "	.... "
NEW ORLEANS TO YOKOHAMA.		
Via Cape Horn	20,227 "	11,590 "
Cape of Good Hope	18,625 "	9,988 "
Suez Canal	17,039 "	8,402 "
Panama R. R.	10,611 "	1,974 "
Isthmus of Tehuantepec	8,637 "	.... "
NEW ORLEANS TO AUCKLAND, N. Z.		
Via Suez Canal	18,381 "	10,286 "
Cape of Good Hope.	17,259 "	9,164 "
Cape Horn	14,314 "	6,219 "
Panama R. R.	9,659 "	1,564 "
Isthmus of Tehuantepec	8,095 "	.... "
NEW ORLEANS TO MELBOURNE.		
Via Suez Canal	16,683 "	6,947 "
Cape Horn	15,640 "	5,904 "
Cape of Good Hope	15,560 "	5,824 "
Panama R. R.	11,181 "	1,445 "
Isthmus of Tehuantepec	9,736 "	.... "
NEW ORLEANS TO HONOLULU.		
Via Cape Horn	16,251 "	10,917 "
Panama R. R.	7,294 "	1,960 "
Isthmus of Tehuantepec	5,334 "	.... "
NEW ORLEANS TO SAN FRANCISCO.		
Via Cape Horn	16,112 "	12,551 "
Panama R. R.	5,418 "	1,857 "
Isthmus of Tehuantepec.	3,561 "	.... "

TABLE OF COMPARATIVE DISTANCES IN STATUTE MILES.

	Total Distance.	Excess over Tehuantepec Route.
NEW YORK TO VALPARAISO.		
Via Cape Horn	10,051 miles.	3,682 miles.
Panama R. R	5,417 "	.... "
Isthmus of Tehuantepec	6,369 "	.... "
NEW ORLEANS TO VALPARAISO.		
Via Cape Horn	10,476 "	5,436 "
Panama R. R.	4,772 "	.... "
Isthmus of Tehuantepec	5,040 "	.... "

On these eighteen routes the aggregate saving in distance by the Tehuantepec Route is over 125,000 miles.

The sailing distances saved are about fifty per cent greater than those given in the tables, the latter being steamer distances.

The great advantage of this route is still more appreciated from the fact that it saves nearly *two and one-half months* time to nearly every vessel which now goes around Cape Horn, and about *$12,000* on the cargo.

During the last few years there have been made several estimates of the tonnage that may be expected to pass through a ship canal or over a ship railway. The following table is made up from information taken from reliable sources. It agrees very closely with that made in 1879 by the statisticians of the Panama Canal Congress:

Detailed Statement of Tonnage expected over the Ship-Railway in 1889.

Routes by which Commerce Moves.	Tons 1883. Actual Tonnage carried by steam and sail on routes longer than via Tehuantepec.	Tons 1889. Estimated from ratio of increase of commerce on the routes from 1879 to 1883, and from new business to be developed.
1. Panama Railroad	77,958	60,000
2. U. S. Pacific Coast with Atlantic via Cape Horn	237,341	359,081
3. Atlantic ports with Countries west of Cape Horn	349,454	489,135
4. U. S. Pacific Coast with foreign Countries east of Cape Horn	1,423,737	2,135,605
5. European Countries with Countries west of Cape Horn, other than U. S	1,828,621	2,285,776
6. British Columbia (Pacific Coast) with Europe	125,000	235,000
7. Slow bulky freights now going over Transcontinental lines	400,000	600,000
8. Fifty per cent. of tonnage now going from Asiatic Countries to Europe via Cape of Good Hope	400,000	400,000
9. New trade to be developed by Ship Railway between Gulf Ports of U. S. and Mexico and Pacific Ocean	.....	1,000,000
Total	4,842,111	7,564,597

This amount may not be realized immediately after the opening of the railway, but we are confident that it will be developed in a few years. It is safe to assume that at the outset the Ship-Railway will carry at least 3,000,000 tons which will probably increase to 6,000,000 within five years from the time of opening the railway for business. A special committee of the Board of Trade of San Francisco, in 1880, stated :

"Ten years since the estimated tonnage that would use the "American Interoceanic Canal was placed, by the best official "authority in the country, at 4,100,000 tons per annum. Careful "estimates made by your committee place it at 5,250,000 tons at "this time."

The following are the provisions of the Ship-Railway concession granted by the Mexican Republic to Mr. James B. Eads, May 28, 1881 :

It provides for the construction and operation, for ninety-nine years, of a ship-railway with its corresponding lines of telegraph across the Isthmus of Tehuantepec. The right of way is granted eight hundred metres wide (2624 feet, or nearly half a mile) across the Isthmus. This width is reduced in town lands to four hundred metres, and is increased where stations are necessary to sixteen hundred metres. The public lands within this belt are conceded gratis to the company. Full authority is given for the prompt condemnation of all private lands needed. Four thousand two hundred square kilometres of public lands, equal to a million acres, are granted in aid of the enterprise. The right is given to import, free of duty, all kinds of machinery, instruments, coal and materials necessary for the construction, operation and maintenance of the works during ninety-nine years.

Vessels, passengers, and merchandise in transit, will be free of all kinds of duties, general as well as local, during the time of the concession.

The property and capital invested in the enterprise, its bonds and shares of stock, are exempted from all taxation or contribution of any kind, except that of revenue stamps, the Constitution of Mexico prohibiting the release of the latter tax by Congress.

Authority is given to collect a maximum toll on each vessel, not exceeding five dollars per cubic metre, for each metre contained in a parallelopipedon, of which the dimensions shall be the greatest length and the greatest breadth of the vessel measured at the surface of the water, and her greatest immersed depth. This would be about $8.00 per ton on the cargo carried. For each passenger carried across, a sum not exceeding $15.00 may be charged.

Gold and silver and precious stones may be charged a maximum rate not greater than one per cent. of their value.

The right is granted to collect wharfage dues and tonnage dues, not exceeding $1.00 per registered ton.

The tariff of charges for telegrams, for a message of ten words, not

counting date, direction and signature, is fifteen cents for one hundred kilometres (about 62 miles) in distance.

The vessels, troops, and all things belonging to the Mexican Government, including telegraph messages, shall be carried free.

Passage over the railway shall be open for all the vessels of all the nations not at war with Mexico, and the Republic binds itseif not to close to ocean commerce, during the term of the concession, either of the two terminal ports of the ship-railway, one in the Gulf, the other in the Pacific, except in case of war.

The directors, agents, employes and workmen of the company shall be exempt during the whole period of the concession from all military or civil service, and considered as invested with all the exemptions and privileges granted to the employes and workmen of other railways in the Mexican Republic.

The company, which may be organized by the concessionaire, may exercise all rights, powers and privileges in relation to the issue of bonds and other guarantees, not in conflict with the laws of Mexico, and may enjoy any concession which it may obtain in Mexico or elsewhere, provided the same be not in conflict with the provisions of the concession.

The company is forbidden to sell, mortgage or alienate, to any foreign government or governments, any of their property or rights conveyed under this concession ; but in consideration of the magnitude of the work, the company may obtain aid from any foreign government, either in money or guarantees, and hypothecate the net revenues to it, and may transport its mails, ships, property and appurtenances, free of charges, and may reduce the tariffs on its commerce and the prices of passage, in such case making the same reduction to the commerce of Mexico.

In the event of failure on the part of the company to comply with any such stipulations made with a foreign government, such foreign government shall have the right to enforce its claims before the courts of Mexico, in accordance with the laws of Mexico, but in no case can such foreign government acquire the ownership of the works, or the rights emanating therefrom.

The concession provides that the company shall be Mexican, even though some, or all of its shareholders, be foreigners, and shall be subject exclusively to the jurisdiction of the tribunals of the Republic, in all matters of which the cause and action may take place within its territory ; and its shareholders, employes, or successors shall not be permitted to allege, with regard to title or property and other matters connected with the company, rights as foreigners under any pretext whatever. They shall have those rights, and the means of making them valid, which the laws of the Republic confer on its own citizens, and consequently not subject to interference on the part of foreign diplomatic agents.

Work on the railway shall commence within two years from May 1st, 1881, and shall be finished within twelve years from the same date, no obligation existing to construct any definite amount of the work during any particular year.

The following valuable provisions have recently been added to the concession by the Mexican Government:

First: The Government of Mexico agrees to guarantee that one-third of the net revenue of the company for fifteen years after its railway is in successful operation shall amount to $1,250,000 per annum, and it gives the right to the company to secure a similar guarantee to the amount of $2,500,000 in addition, from one or more foreign governments which may be disposed to aid the enterprise. The net revenue in all cases shall be assumed as one-half of the gross receipts of the railway.

Second: Authority is given to the company to admit to the Board of Directors members appointed by the guaranteeing foreign government, to represent its interest, equal in number to those appointed by the Government of Mexico, namely: two-ninths of the whole number or four-ninths of the board on the part of the two governments. Provision is made that when the net revenue reaches a certain amount these government directors shall have the right to reduce the tariff of charges, and with the sanction of their respective governments establish lower rates.

Third: The Mexican Government also gives to the company the right to establish coaling stations at each end of the line for the supply of vessels in transit over the railway, with the right to import coal for this purpose free of duty.

Fourth: It extends the time for completing the railway two years beyond the terms of the original concession, or to 1894.

Fifth: It increases the original land grant one million seven hundred thousand acres, the total being two million seven hundred thousand, about one-half the area of the State of New Jersey.

A proposition to incorporate the "Atlantic and Pacific Ship-Railway Company," is now before the Congress of the United States. The following are its more important provisions:

The Government is asked to guarantee that two-thirds of the annual net revenue, for fifteen years after the railway is completed and in operation, shall amount to $2,500,000; the United States to make up any deficiency in this amount; the guarantee not to take effect until a vessel weighing, with cargo, 3000 tons has been taken from the water, transported over the railway at a speed of not less than six miles per hour, and launched in the harbor on the other side of the isthmus without injury to the railway or vessel;—this test to be made to the satisfaction of a commission appointed by the President of the United States. The amounts, if any, advanced under the guarantee are to be refunded to the Government out of the receipts of the railway; the Company to issue bonds binding itself to pay the sums advanced;

one-third of the excess of annual net revenue over the amount of the guarantee to be paid by the Company to the Secretary of the Treasury. The amount advanced is, therefore, a reimbursable loan, for the payment of which the Government has security in the bonds of the Company and the receipts of the railway until the whole amount is refunded. The Company agrees to transport during the fifteen years, all Government vessels, property, mails and officials, and transmit all Government telegraphic messages, for the nominal gross annual sum of $500. The Company also agrees that, during thirty years after the completion of the railway, it will transport vessels belonging to the citizens of the United States, and registered under its laws, engaged in coast-wise commerce, for 75 per cent. of the regular tolls aud charges imposed upon the commerce of all other nations excepting Mexico. The United States is to have the right to be represented by two-ninths in the Board of Directors of the Company. When the annual net revenue shall exceed 10 per cent. of the total indebtedness, the Directors of the United States and Mexico may establish a tariff of reduced rates. The Company is prohibited from transporting any vessels of war, ammunition, troops, or contraband of war, of any nation at war with the United States or Mexico. The above proposition is thus seen to be in all its provisions fair and reasonable. For an obligation comparatively insignificant in amount, the United States will secure immense benefits to its commerce, its industries and its general welfare.

The beneficial effect upon the manufacturing industries of this country will be felt from the commencement of the work. There will be required in the construction of the railway over 10,000,000 feet of lumber; 4,000 tons of iron bridges: 70,000 tons of steel rails, splices &c.; 8,000 tons of steel in the docks and basins; 12,000 tons in the carriages; and 10,000 in the floating turn-tables; besides a great variety of other materials and plant which can be drawn from this country. The benefits to Mexico will be the employment of probably 10,000 of the Isthmian population, who are robust, active and faithful laborers. The provision of the concession which permits all coal to be imported free of duty for the use of the railway and for supplying steamers in transit, will open a large and profitable market for the coal of Alabama, Indiana, Illinois, Kentucky, Tennessee and Pennsylvania. In conclusion, the company urge this government to encourage this great undertaking, confident of results grandly beneficial to our country.

The language of a memorial to the Senate and House of Representatives, presented by the Board of Trade of San Francisco, in 1880, is eminently appropriate in 1885:

"Your memorialists therefore pray, that when an organization "with proper guarantees applies to you for recognition and official "encouragement, the Government of our country will assume the "protection, and support with its moral influence, the execution of

" this great work, upon which so much depends. Your sanction " and your encouragement will make this essentially an *American* " *Enterprise*, and afford such a guarantee of success as will attract " the capital of Europe to complement our own. Our coast, our " country and the world are ready for this great and beneficent " enterprise."

CHAPTER VII.

STRONG APPROVAL OF THE SHIP RAILWAY ROUTE AND METHOD, AND OF GOVERNMENTAL ENCOURAGEMENT, BY TWO COMMITTEES OF THE 46TH CONGRESS.

The conclusions of the Committee of the House of Representatives (46th Congress, 3d session, Report No. 372,) are given in the following unanimous Report of the Senate Committee of the same Congress.

The examinations of these two Committees were thorough and exhaustive. The testimony taken by them in favor of the practicability and economy of the Ship-Railway was from the highest sources. The proofs are convincing, and the conclusions of the Committee are irresistible.

The Committee on Commerce, to whom was referred the bill (S. No. 430, 46th Congress,) to incorporate the Interoceanic Ship-Railway Company, and for other purposes, have had the same under consideration, and beg leave to submit the following report :

The first question the committee considered was as to the practicability of constructing a railway for the purpose of transporting ships and their cargoes. The testimony before the committee conclusively demonstrates the fact that such a railway is entirely practicable, and that loaded vessels can be transported over the same with absolute safety and economy.

The committee does not consider it necessary to enter into the details of the proposition thus stated, but refers to the following testi-

mony upon the subject, given by the most prominent and able engineers and naval architects in the world.

In the first place the committee would refer to the testimony of Sir Edward J. Reed, K. C. B., late chief constructor of the British navy, who, in passing through Washington, kindly appeared before the committee at its invitation, and gave it the benefit of his views. The statement of Sir Edward Reed will be found printed in full in the testimony taken before the committee. Specific reference will now be made only to some of the matters therein contained.

In one part of his statement he says:

I have no hesitation in saying that the modern ships of to-day are vastly stronger everywhere than they were half a century ago, and that they are now, as a rule, perfectly capable of being docked in dry-docks with their cargoes on board. Of course, if they can be docked in a dry-dock (a graven and sunk dock,) they could be docked upon an iron lifting or hydraulic dock.

Again he says:

I should like to say at first that, as a naval constructor, I have no fear whatever of a ship undergoing any strain in the process of lifting out of the water (as would be necessary in the case of a ship-railway,) that she is not liable to at present in ordinary docking. I would say, further, that I am quite sure that the processes of ordinary docking, as carried on in a vast number of private establishments, are very negligent and insufficient in comparison with those which would be adopted in the case of the hydraulic lifts connected with the proposed ship-railway.

In speaking of the docking of armor-clad ships upon the celebrated hydraulic docks at Bombay, Sir Edward says:

Therefore to dock an armor-clad ship is really to dock a ship with the principal part of her cargo on board, and under very unfavorable conditions, because the cargo of an iron-clad may be said to consist of her armor chiefly, and that is all situated upon the extreme outside of her, and acts with great leverage as regards the keel, whereas an ordinary cargo is laid over the bottom of a ship, and is more or less equally distributed. This dock at Bombay has been in operation several years, and has docked her Majesty's ships several times, and some others, and there has been no sort of accident or complaint of any kind. On the contrary, everybody has been surprised to find that in no case has an accident occurred, whereas accidents in ordinary docks are not uncommon.

In speaking of the hydraulic docks at Malta, Sir Edward says:

I have here a letter from the secretary of this hydraulic dock company giving a list of some of the vessels which have been docked with cargo on board. I will only pick out two or three of these. There is a vessel called the Volmer, of 1,531 gross tons, which went in with a cargo of 1,200 tons' weight. A ship of 2,134 tons' gross tonnage went on the dock with 1,700 tons of cargo aboard; a ship of 1,555 gross tons went into dock with 1,500 tons of cargo, and others of like proportion of cargo to the size of the ship.

I would call attention to the fact that although ship-owners were at first afraid of docking ships in that way, with their cargoes on board, they have discovered by the experience of years that no sort of injury does result therefrom. The ships that are in the Indian trade now voluntarily employ these docks and go upon them with their cargoes on board for the purpose of getting their bottoms cleaned and coated on the voyage, instead of having to lie in a more expensive dock in London for the purpose.

Again he says:

I would not like to dwell longer upon what I believe is the perfect practicability of docking wooden or iron ships with cargoes if they are docked with care.

Again he says:

I would like to mention what I think would be the view which I would take of this question if I were an American citizen, even if there were doubts about the perfect security with which you could take some of your not very strong wooden vessels across the isthmus. I should say that the time had come when it would be worth the while of this country to take command of its own transit by such a route as this, or rather to give encouragement to it for the purpose of developing in America that which America ought to possess, namely, the means of conducting the transport of its own produce from one port to another.

* * * * * * *

I should say, as an American, if our ships are not adapted for this purpose at present, let them be made so.

* * * * * * *

It would be very improper for me to press the adoption of this system upon gentlemen like you, because to tell the truth, I am not anxious that it should be adopted in the form in which Captain Eads put it. Looking to the enormous shipping interest which we have (we are 60 per cent. now in England of the carrying power of the world), I am quite satisfied that this enterprise can be dealt with by British ship-owners and capitalists, and I am quite sure also that when dealt with in the present day, and with interests of the kind we now have at home, they would obtain the protection of the government for their enterprise. The premium of having half rates for the whole British shipping passing over that isthmus would be so great a temptation that I would like myself to get Captain Eads to come over and ask us to take this thing up. But, however, as an American enterprise, I think it has great merit, and cannot fail, if constructed under the auspices of the United States Government, to greatly benefit your commerce.

Again, in speaking of the allegation made by some that in the transportation of ships by railway there would be much jerking and vibration, which would be liable to cause damage, Sir Edward says:

They seem to think there are some vibrations or jerking, or forces of some kind the ship would be subjected to on the railway that she is not subjected to at sea. That feeling, I know, is a pretty general one. I can only attribute it to the fact that the gentlemen who so think are not acquainted with the strains that ships undergo at sea.

Again he says:

The next thing I would say is that we have ships on railways, and we have them in the worst form. Nothing is commoner than heaving up slips upon which ships are pulled up out of the water. They have to take their bearing first at the bow, and gradually come up until they get upon the solid, and are then hauled up by chains.

That has been done everywhere, all over the world, thousands of times in this country, and it is now carried on to a very large extent indeed. With docks for ships of 3,000 or 4,000 tons, nothing is thought of pulling these ships up, and nothing is thought of any strains they undergo under the circumstances.

In speaking of the liability of ships while in transit to be blown over by violent storms, Sir Edward says :

If it is sufficient on a ship-railway to provide against something like the worst hurricanes at sea, then I have no hesitation in saying that it is perfectly impossible for these ships on the railway to come to any grief from wind, because the resistance to hold the ship upright on her cradle on the railway track is, I think, very many times greater than the forces which keep her upright at sea.

After speaking of the track and locomotives which would be required for the ship-railway, Sir Edward says :

With a track like that, and with locomotives adapted to it, there would be no difficulty in transporting ships. It would be best to avoid a very high rate of speed. It would not be necessary, I should think, to move these ships at a greater speed than eight or ten miles an hour, although I am quite prepared to believe that, with a proper track and locomotives, vessels could be transported very much faster. I think the ship-railway would be likely to develop as much as the ordinary railway has done, and create as many surprises ; but in any case I cannot, for the life of me, understand where is to enter in the danger to a ship upon a car traversing a road such as may be made and would be made for this purpose. I have searched for it in vain, and I cannot find the element of danger.

In answer to inquiries in relation to the economy of the ship-railway as compared with a canal, Sir Edward said :

I have made some calculations as to the weight of the car and the weight of the ship, but as those calculations are set forth in a letter, which, perhaps, the committee may do me the honor of reading, I should not like to go back upon memory for those figures.

In the letter to which he refers, Sir Edward says :

As regards the comparative economy of transporting a ship's cargo by canal or railway, I am inclined to believe that the railway would prove the more economical of the two.

It was stated in evidence before a committee of the House of Commons, by the chairman of the Great Eastern Railway Company, on the 7th March, 1878, that coals could be profitably transported by this company at the rate of ¼d per ton per mile ; and this was confirmed by the locomotive superintendent of the Northwestern Railway, on the 21st of March, 1878. If we assume that the total distance to be hauled across the Isthmus of Tehuantepec is 150 miles, it would appear that a ship's cargo can be profitably carried for that distance, in the ship, over a first-class railway, for $0.75 per ton. I arrive at this conclusion from the following considerations : 1st, ¼d, or one-half cent, per mile gives $0.75 per 150 miles ; and 2d, the weight of the ship and car upon which she is transported appears to bear about the same ratio to the cargo carried in the ship when fully loaded, that the weight of the coal-car bears to the weight of coals it carries. It was also stated in evidence, on the occasion above referred to, that the weight of coal carried on one truck is 7¼ tons, and the weight of the truck 4¼ tons. The paying load is, therefore, about 58 per cent. of the total ; and this is about the proportion that the cargo would bear, in many ships, to the total weight of the ship, car, and cargo. These facts are sufficient to show that the transport by ship-railway, over a first-class road with easy gradients, in a country where fuel is abundant and labor not excessively dear, ought to be about the same per ton per mile, for the cargo carried, as in England. If, however, we assume it to be twice as expensive, the rate would then be $1.50 per ton across the Isthmus of Tehuantepec. I am credibly informed that at this time $20 per ton is being paid for the transport of grain from California, round Cape Horn, to Liverpool

It should be borne in mind that there are two elements in the ship-railway plan proposed by Captain Eads which tend to greater economy than is obtained in the railway system of England: 1st, the ship-railway will be devoid of all curves; and, 2d, the cargo transported will be handled wholly by machinery, and in vast bulk.

The committee will not, however, occupy more time in quoting from the testimony of Sir Edward J. Reed. The whole of that testimony is very valuable and instructive, and will well repay perusal.

But the question of the practicability of a ship-railway does not depend alone upon the testimony of one engineer, however distinguished. Mr. Eads submitted to the committee a number of letters and certificates from the most distinguished engineers and naval architects abroad and in this country. Attention is called to the following extracts from some of these certificates and letters.

Nathaniel Barnaby, C. B., present chief constructor of the British navy, in a letter dated London, October 8, 1881, says:

I note, therefore, the question you wish to put to me, which is: "Do I think the problem insoluble of constructing a car on which a fully loaded ship can be safely transported over such a railway as could be built through a tolerably level country?"

In reply to this, I say not only that it is soluble, but that the solution is, in my opinion, fairly indicated in your plans, as laid before the committee on interoceanic canals and shown to me.

Ships which would be strained by ordinary docking would be liable to be strained also when suspended on a car not specially designed for their crazy condition, but such ships would be still more strained in their ordinary sea passages.

Mr. William John, who was for some years the scientific adviser of the committee of Lloyd's Register of British Shipping, London, and who built the Inman steam liner the City of Rome, in a letter dated October 6, 1881, says:

The practice of lifting a ship of large size clean out of the water has become an every-day occurrence. The further step of lifting her to a considerable height is not a great one, especially if you can start with her floating in a considerable depth of water. Beyond these the conveyance of her over a railway, provided the latter is moderately level and moderately straight, is a simple matter, which is certainly not outside the reach of civil engineers.

Mr. John Fowler, who was consulting engineer of the Egyptian Government, engineer in chief of the Metropolitan (underground) Railway of London, and who is a past president of the Institute of Engineers in England, says:

You will be interested to know that about eight years ago, when acting as consulting engineer to the Egyptian Porte, I was instructed to prepare a project for the transport of steamers and other vessels from one level to the other at the first cataract of the Nile.

After a very careful investigation of the alternative plans of canal and ship-railway on the spot, I decided in favor of the railway, having satisfied myself that there was no mechanical difficulty in carrying ships of any size, without injury to themselves, on a properly designed car or cradle over a solidly constructed railway.

Mr. George Fosbury Lyster, a member of the Institute of Civil

Engineers, in England, and engineer in chief of the Liverpool docks, in a letter dated November 2, 1881, says:

In reply to your letter of the 16th ult., referring to the several interviews I have had with you during your recent visit to this country, on the interesting subject of your proposed ship-railway across the Isthmus of Tehuantepec, as also to the papers which you were good enough to leave with me, further illustrating your opinions on the point, I have now been able to give the whole matter, as far as its engineering features are concerned, very careful consideration, and have concluded that if the permanent way, cradle arrangements, and general details are carried out in the ingenious and substantial manner you described, there will, in my judgment, be little or no difficulty in transporting properly constructed ships from sea to sea with entire convenience and safety.

Mr. E. Leader Williams, a member of the Institute of Civil Engineers in England, in a letter dated September 5, 1881, says:

I believe that your ship-railway only requires carrying out into execution to prove most successful in every way.

The firm of Clark & Standfield, distinguished English civil engineers, one of the members of the firm (Mr. Edwin Clark) having been the chief assistant of Robert Stephenson in building the celebrated tubular bridge over the Menai Straits, and who introduced the hydraulic vertical-lift system, in a letter to Mr. Eads, dated London, September 6, 1881, says:

Referring to our interview on the subject of the proposed ship-railway across the American isthmus, we now beg to say that our works are likely to be so much occupied during the next year that we should scarcely be in a position to execute any works out of England in connection with the proposed railway, but we should be very happy to prepare the drawings for the construction of the terminal works, for lifting the vessels at the Atlantic and Pacific Ports.

We understand it will be requisite to transport loaded vessels of the weight of 4,000 to 6,000 tons, more or less, on the railway, at the rate of about six miles per hour, on a gradient of one or two per cent., and that it will be required to raise the vessels on a railway car out of the water to a variable height, not exceeding 46 feet, and deposit them on the rails in a time not exceeding thirty minutes. These conditions may be fulfilled in two different ways, and we need not say that it is a plan in which Mr. Edwin Clark has entire confidence, and in which he will take the fullest interest in arranging the details. The hydraulic system would probably be the most rapid, but probably the more costly. At the Bombay hydraulic dock we have lifted weights up to 12,000 tons, with 72 presses, 14 inches diameter, and 36 feet stroke. The Victoria and Malta hydraulic docks have been many years in constant operation.

At the canal lift at Fontinettes we employ presses with rams, 6 feet 7 inches in diameter, with a 50-feet stroke. Each of these presses will raise a dead weight of 1,000 tons through a height of about 50 feet in three minutes. The weight is a movable portion of the canal, about 132 feet long, containing the water and a barge floating in it. This work is now in course of construction for the French Government, and it is to be erected near St. Omer, in France, and we are now designing a set of four similar canal lifts for the Belgian Government, in which the weight raised will be somewhat larger. It is evident that a few presses such as these would more than accomplish the work required.

Our ordinary depositing dock, similar to that at Sebastopol, which raises vessels of 6,000 tons, would also meet the requirements of the case very satisfactorily. We are now constructing a second of these docks, of 10,000 tons, for the Russian Government at Vladivostok, and a third, of 3,000

tons, for the Barrow and Railway Company, at Barrow-in-Furness, to be afterwards increased to 5,000 tons. We have designed one of these docks for the Italian Government, to raise ironclads of 15,000 tons' weight with a lift of 30 feet. There would be no difficulty in modifying the proportions so as to render it suitable for a lift 46 feet, and this form of dock raises the vessels out of the water and deposits them on a gridiron stage in a most convenient manner for railway transport.

It will probably depend to a great extent on their relative cost as to which of these systems may be adopted, and we shall be prepared at any time to go into the necessary calculations, and render every assistance in our power towards the accomplishment of the great work in which you are engaged.

We apprehend no difficulty in perfecting the necessary details of the plans so as to insure the safe transportation of the largest loaded ships on the railway cars with absolute safety.

The firm of Emerson, Murgotroyd & Co., who were the constructors of the hydraulic docks at Malta and Bombay, say, in a letter dated October, 1881 :

JAMES B. EADS, Esq., *C. E.* :

MY DEAR SIR : When you are ready to commence the construction of your ship-railway, we shall be pleased to undertake the building and completion of the necessary works for placing the ship, with her cargo, on the railway track, ready for attaching the locomotives to her, and after transport across the isthmus to lower her safely again until she is afloat. A lifting apparatus will be required at each side of the isthmus which will lift or lower ships as required. This portion of the work we are fully prepared to execute with the greatest promptness, on the same terms on which we built the hydraulic docks at Bombay and Malta, and the Anderton Canal Lift in Cheshire.

We have no hesitation in guaranteeing the lifting of a fully-loaded ship or steamer of 8,000 or 10,000 tons' weight on a railway car from the sea or harbor level to that of your permanent way in thirty minutes, with absolute safety to the ship and the works, where the lift is not over fifty feet vertically. We will undertake to construct all the plans and works necessary to do this at each end of your line, and complete everything ready for attaching the locomotive to the car on which the ship is to be lifted and transported ; this car, or any number of them, we will furnish also.

The locomotives and railway construction are not in our line ; but if it were a matter of importance to cover, in addition, the construction of the locomotives, turn-tables, &c., and ten miles of railway, as proposed by you to the United States, we have no doubt we could unite with us some other responsible parties engaged in that kind of works, to execute them and guarantee the safe transportation of the loaded ships of the weight mentioned, over the railway.

Mr. William Pierce, sole proprietor of John Elder & Company's works, Govan, Glasgow, and who built the Arizona, the Elbe, the Alaska, and others of the largest and finest steamers afloat, in a letter dated August 26, 1881, says :

I am of the opinion, from what I know of the working of iron floating docks that I have designed and built, that iron steamers of 4,000 to 5,000 tons' displacement may be docked loaded, without any injury whatever.

It is also my opinion that a ship-railway for vessels of this size may be constructed and worked successfully, provided the land is solid and the line moderately level.

Captain Edward Hartt, United States Naval Constructor, says, in a letter dated Orange, N. J., January 22, 1881 :

With a substantial road-bed for your railway, on the easy grades across

Tehuantepec, which, I understand, do not exceed one or two feet in the hundred, there can be no mechanical difficulty in the way of transporting loaded ships by railroad with entire safety to the vessel, whether they be built of wood or iron.

Mr. H. L. Fernald, another constructor in the United States Navy, says:

Having carefully examined the plans and papers pertaining to your proposed ship-railway across the Isthmus of Tehuantepec, I do not hesitate to say that, in my judgment, there will be no difficulty whatever in transporting, in the manner you propose, any properly built vessel with absolute safety.

Gen. Q. A. Gilmore, of the United States Engineers, says:

In my judgment the construction of a ship-railway across the Mexican Isthmus, in general accordance with your plan, is not only feasible as an engineering problem, but the successful maintenance and operation of such a road is entirely practicable as a business enterprise.

Major Charles R. Suter, of the United States Engineers, says:

The project has great and obvious advantages to recommend it; and from an engineering point of view, it is, in my opinion, perfectly practicable.

Professor E. A. Fuertes, dean of the department of civil engineering in Cornell University, and chief engineer in the survey made by Commodore Schufeldt, of the Isthmus of Tehuantepec, and who was for eleven months upon the Isthmus, says:

When your ship-railway project appeared, and was ridiculed by inconsiderate engineers, I made computations which proved conclusively to my mind that the Great Eastern could be carried safely overland upon rails with less strain to her timbers than in any of her sea voyages.

Again, in speaking of the grades which would be encountered upon the Isthmus of Tehuantepec, Professor Fuertes says:

I can assure you, upon knowledge of every inch of the ground, that you will find no difficulty about curves, grades or bridges. The ascent of the Atlantic slope will offer no more difficulties than the Hudson River Railroad, and on the Pacific side, either one of three passes in the neighborhood of Tarifa or Chivela will allow of no steeper grade than twenty-five to thirty-five feet per mile to bring you down to the Pacific Plains. The ground offers you fifty miles to get down in, and as much more as you may wish by following the hillside. All the bridges required will be of comparatively short spans. You will find very little anxious work on either terminal harbor, very little tentative work being required, and permanence without ulterior complications will reward almost any kind of attack. The drainage of the works, building materials (including excellent cement yielding dolomitic limestone, between San Miguel and Tarifa), abundant native labor, a remarkably healthy climate, &c., will be all you may desire.

Don Francisco de Garay, whom the French Government made a member of the legion of honor in recognition of his abilities as a civil engineer, and who was detailed by the Mexican Government (he being the engineer of the valley of Mexico), to make a survey of the Isthmus after the concession was granted to Mr. Eads, in a report to Mr. Eads, dated Mexico, September 22, 1881, says:

Now with regard to grades: I have no grade on my line above two per